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Section One

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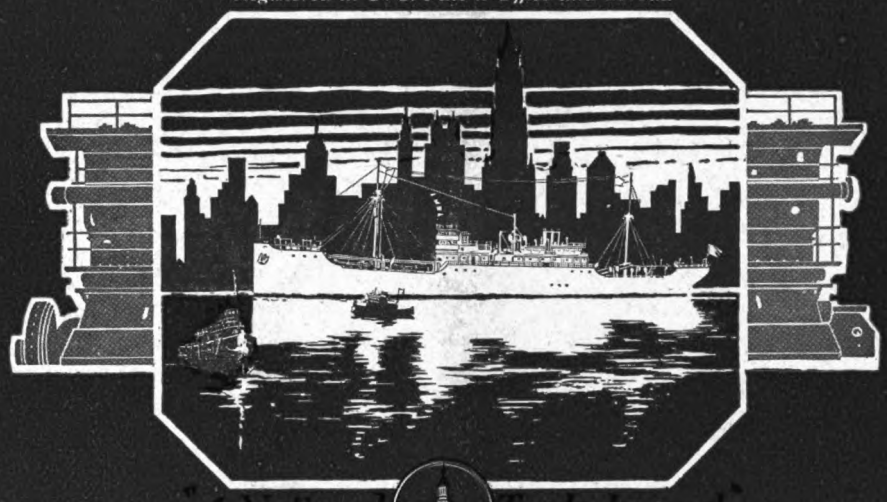

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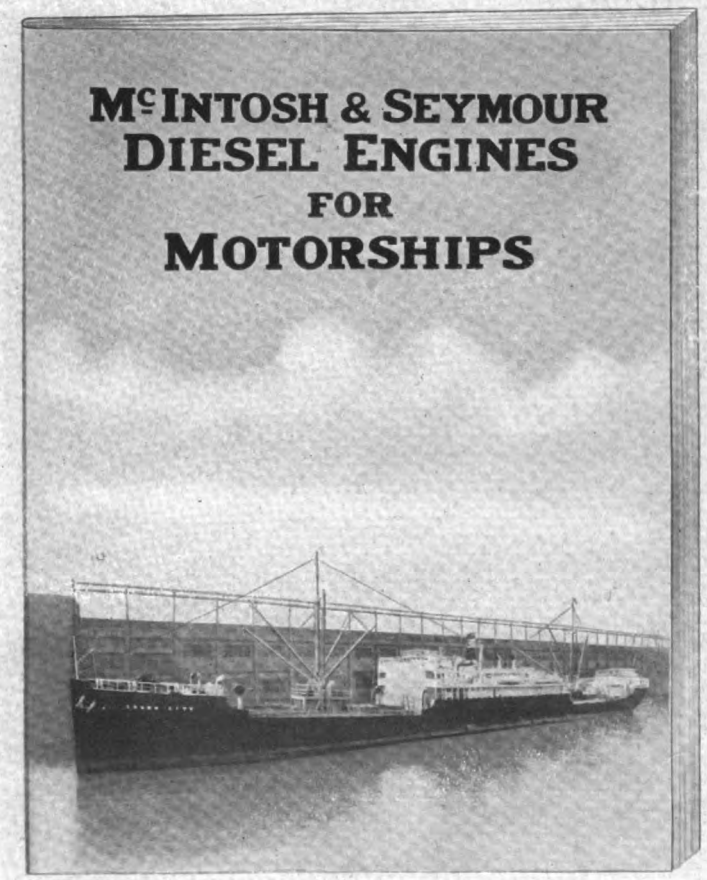

THIS bulletin deals with the latest American practice in motorship propulsion, and includes much data on the United States Shipping Board conversions, private conversions and the application of Diesel power generally to passenger and cargo vessels, tankers, ferrys, etc.

If you are responsible for or interested in profitable ship operation, you will want the correct perspective on Diesel power as outlined in this bulletin and readily understood on careful reading. You will also find the discussion and data well worth filing, as references are based upon the very latest practice and both new and old installations.

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DEC., 1928

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Motorship

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"A National Trade Journal"

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An Important Precedent

WHAT is believed will be the first privately owned American flag passenger and cargo liner to be built in an American shipyard since 1918 for exclusive use in long voyage foreign trade, was contracted for November 22, by the American South African Line, Inc., with the Sun Shipbuilding Company of Chester, Pa. The contract calls for the immediate building of a twin screw Diesel driven combination passenger and cargo ship of the highest class, for use in the company's service between United States and south and east of African ports.

Commenting on the placing of this contract, James A. Farrell, Jr., President of the line said "Although many factors have entered into our decision to construct this fine modern ship, we are primarily responding to the provisions of the Merchant Marine Act of 1928 (Jones-White Bill), which contains features enabling American ship owners to meet some of the inequalities of competition. The plans have been prepared under the supervision of our Directors, John J. Farrell, Arthur R. Lewis and Leigh C. Palmer, who have been studying the trend of foreign construction for some time past."

The main propelling machinery will be two sets of Sun-Doxford Diesels, developing in excess of 5000 s.hp., capable of producing a sustained sea speed in ordinary weather of 13 knots. All auxiliaries are to be electric, the power for which is to be generated in three Diesel direct driven motor generator sets.

The principal dimensions of the vessel are to be length 470 ft. 8 in., moulded breadth 61 ft. 6 in., loaded draught 26 ft. at which depth the cargo capacity is to be 10,000 tons dw. The hull designed on the transverse frame system, is modern in every detail, being of the three deck type with extended forecastle, long bridge and cruiser stern, with a capacity below decks in excess of 464,000 cu. ft. bale measurement for cargo.

Especial attention has been given to features which will enable the ship to load, transport and discharge miscellaneous cargo, economically and safely. Double rigged hatches will permit her to handle the wide variety of merchandise exported to and imported from South Africa.

Accommodation is provided for 60 first class passengers. All passenger rooms are located outside on the upper deck and are so ventilated as to give maximum comfort in tropical climates. Many of the rooms have adjoining baths. The public rooms, three in number, comprise ample and well appointed lounge, smoking room and dining room. The vessel is expected to be completed and ready for service in December, 1929.

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Courageous, Triumph and Defiance

PUBLISHED with this issue and presented without charge to all subscribers to MOTORSHIP, is a very handsome and valuable Colored Supplement devoted entirely to the first three Diesel-electric ships completed for the U. S. Shipping Board, namely, the COURAGEOUS, TRIUMPH and DEFIANCE.

Owing to this Supplement being printed and bound separately from the regular issue, it is not practical to distribute the same on the newsstands in conjunction with the regular December issue of MOTORSHIP. We are reserving a limited number of copies for non-subscribers who can obtain them at the cost of $1.00 each, including postage.

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Volume XIII *December, 1928* *Number 12*

Mammoth Diesel-Electric Pipeline Dredge for Panama Canal

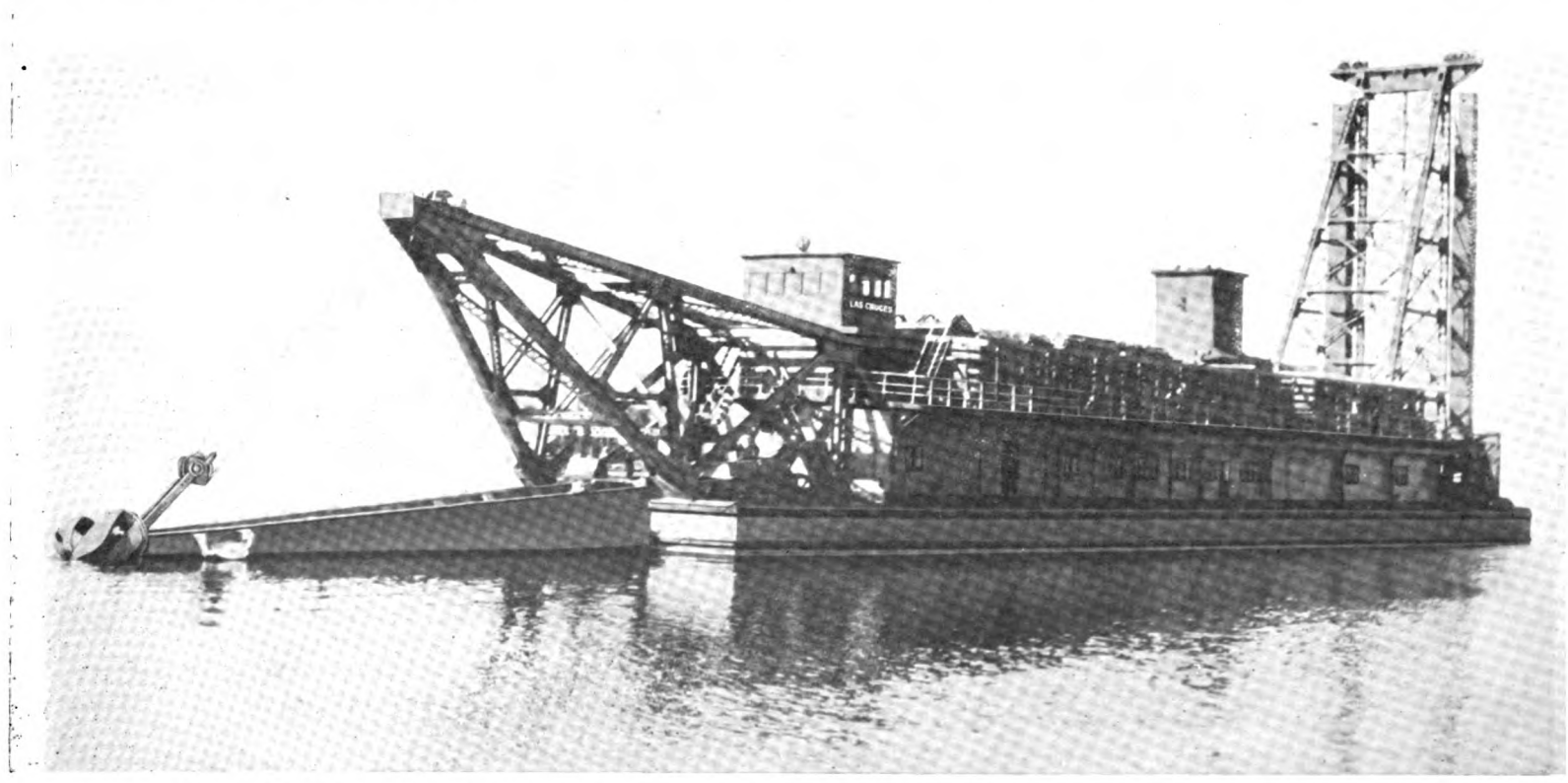
Capable of Doing Twice the Work of the Largest Steam Dredge and Relay Booster Now in the Canal Zone

By John C. Claybourn*

WHEN the United States Government completed the purchase of Canal rights and properties from the French company, by the payment of $40,000,000.00, which occurred on April 23, 1904, by the ratification of the instrument of conveyance, the purchase brought with it a vast amount of equipment, a large amount of which was obsolete, but some in such condition as to warrant the expenditure for its reconstruction. It will be recalled that the French company had a large fleet of dredgers or excavators to handle subaqueous or wet excavation. These were of two types—the ladder or endless bucket dredge and the suction dredge.

The principal type used by the French and on which they relied was the ladder type. These might be divided into five distinct classes. The first class consisted of four 60 hp. elevator type, sprocket driven dredges of about 9 cu. ft. capacity. Only one of this type was used and the others scrapped. The second class was a marine type, or self-propelling dredge, which came to the Isthmus under its own steam. These were also of the endless bucket type with buckets of 17 cu. ft. capacity, 32 to 36 buckets in the chain. This type could not dig its own floatation, but were fairly successful where sufficient water was to be

*Superintendent, Dredging Division, Panama Canal.



Diesel-electric dredge Las Cruces designed for service on the Panama Canal and built by Ellicott Machine Co.

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had. Two of the four of this type were rebuilt by the Americans. The third class, a Belgian non-propelled dredge, with box hull, endless bucket chain, of the same capacity and size of the second class, were the ones principally relied upon by the French. There were originally 22 of this class constructed by the French, but only five rebuilt by the American forces. The fourth class consisted of four dredges, probably of American manufacture, details of which are incomplete, and were built with chutes on either side, one 180 ft. in length, for the purpose of conveying material to the bank, back of wooden dams or bulkheads. These dredges were effective in soft material, but had a short life on the Isthmus. When the project was discontinued by the French, these dredges were sold to the Nicaraguan Canal. Three were sunk en route to Greytown, and the other was not operated after arrival. The fifth class consisted of two Suez type dredges, which were a combination of ladder and suction dredge. The material being excavated and elevated by buckets to a hopper, there diluted with water and then taken up by centrifugal pumps which discharged the material on shore. These were apparently not very successful on account of rock encountered and were little used.

Old and New

The second general type used by the French was the suction dredge. There were four of these dredges, equipped with 16 in. centrifugal pumps and 22 small barges, equipped with invincible English made centrifugal pumps, but only 14 of the latter were commissioned and none of them were rebuilt or used by the American forces.

Out of 51 pieces of dredging plant, therefore, which we acquired of the French, only seven were rebuilt and commissioned by the Americans. From 1906 to 1910 the Isthmian Canal Commission secured three dipper dredges of five yards capacity each; two sea-going suction dredges, with twin 20 in. centrifugal pumps, having a hopper capacity of 2,200 cu. yds.; one 12 in. and one 18 in. pipe line suction dredge built on old French hulls and furnished with Morris pumps, and five 20 in. pipe line suction dredges, three of which were purchased from the Maryland Steel Company, (the machinery largely of Ellicott design), and two from the Ellicott Machine Company, the most powerful of which was Dredge No. 86, with approximately 900 hp.

From 1912 to 1916 the Isthmian Canal Commission and The Panama Canal added to this fleet one modern ladder type dredge built in Renfrew, Scotland; three dipper dredges of 15 cu. yd. capacity each, built by the Bucyrus Company and one small Clam Shell dredge, making a total of 24 dredges used by the American forces.

Although the ladder type dredge was considered rather effective in relatively soft material, during the early construction days, it was found that even the lower powered pipe line suction dredges were able to handle as great a yardage at less cost and were able to place the material advantageously in making necessary fills, besides greatly aiding in sanitary work, which the ladder type dredge was unable to do. The ladder type dredges were, therefore, scrapped as rapidly as it was practicable to do so. As a matter of fact only one survived the construction days to 1914, with the exception of the modern ladder dredge COROZAL, which was disposed of in 1920, it being found that the powerful suction dredge type could dig practically as hard a material effectively as this modern ladder type dredge, and at less cost.

By October 10, 1913, the Canal excavation was practically completed, with the exception of the slide at Cucuracha and a few bank breaks throughout Culebra Cut (now called Gaillard Cut). As only a limited number of steam shovels could be concentrated at these points, which entailed a large amount of track maintenance and were therefore much less effective as compared to available dredging fleet which was capable of handling much larger quantities of material in a given time and as the dredges could work 24 hours, while the steam shovels could not exceed 12 hours per day, the shovels were removed; water was let into the Cut and the dredging fleet brought to bear at these points.

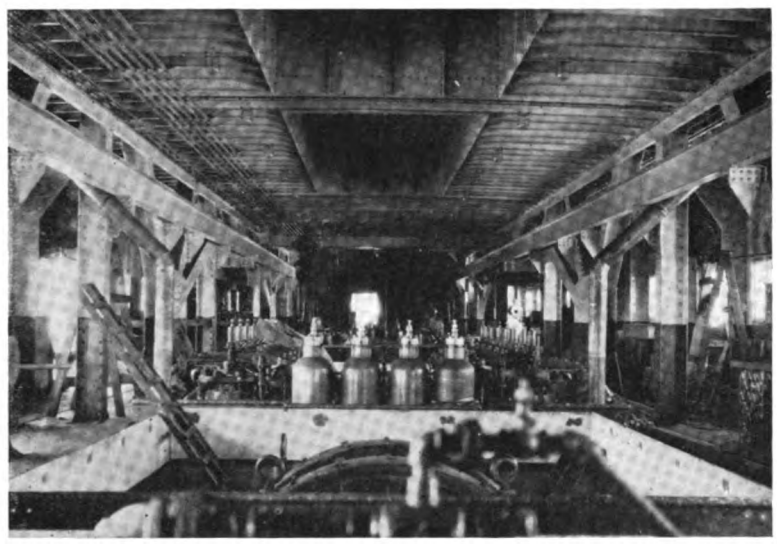
Suction dredges in this work were used to advantage in excavating rehandled material and in sluicing, but dipper dredges were depended upon for the excavation of practically all original slide material on account of the presence of a great percentage of large boulders and rock. The presence of enormous quantities of rock also made it necessary to retire the small 5 yd. dipper dredges and secure in their places, the 15 yd. type. With the advent of the latter, the slide period of the Canal grew to huge proportions, which reached its climax in 1916. This condition has slowly decreased in importance as corrective methods were applied so that the suction dredge became more and more of importance as a maintenance piece of equipment.

Need for New Dredge

The large dipper dredges are, therefore, now being used on special maintenance work and on improvement projects where rock is encountered and are especially held in reserve for slide emergency. The suction dredge is mainly used for ordinary maintenance work in the canal channels and harbors and for auxiliary work where flls are required. The ordinary maintenance work of the canal channels covered by suction dredges now, approximate 38 miles in length.

The total excavation by the United States Government from the canal prism and harbors to March 31, 1928, was approximately 338,914,850 cubic yards. Of this amount 238,822,850 cubic yards were wet excavation, of which approximately 135,000,000 cubic yards were excavated by suction dredges.

With the completion of the canal, suitable dumps for the disposal of spoil became more and more remote from the areas to be dredged, necessitating more powerful hydraulic dredging equipment. This requirement was met temporarily by the design of a floating relay booster plant, which worked in conjunction with the suction dredge in relaying the material through long pipe lines or over high elevations or both, which were beyond the range of our low powered hydraulic dredges. Our present combination, however, has not proven adequate to keep up with the ever-increasing maintenance work demanded of this type of plant, and it therefore became necessary to purchase a more powerful hydraulic dredging unit in order to cover the necessary territory at proper intervals and still maintain the low unit cost.



Spaciousness of the interior is indicated in this view looking forward and showing the hauling machinery pump and pump motor.

The problem was to secure a plant flexible in power, for long or short pipe lines, for low or high elevations, or a combination of these conditions, with a great output capacity, manned by the least number of men, by virtue of which we could cover a great expanse of territory quickly and which would insure us of a relatively low unit operating cost, whether or not the equipment was working whole or part time. The answer to this problem was the design of the powerful Diesel-electric, 24 in. hydraulic or pipe line dredge, LAS CRUCES.

In purchasing the LAS CRUCES, the authorities on the Isthmus were thoroughly familiar with the recent progress in hydraulic dredge design, and issued their specifications incorporating these ideas in a special plant covering their needs.

By direction of former Governor General M. L. Walker, and under the immediate supervision of Colonel Harry Burgess, then engineer of maintenance, and at present the governor of the Panama Canal, Captain R. P. Schlabach, naval constructor—formerly superintendent of the Mechanical Division—and Mr. John G. Claybourn, the superintendent of the Dredging Division, were appointed to draw up the specifications covering the general requirements for a Diesel-electric dredge suitable to

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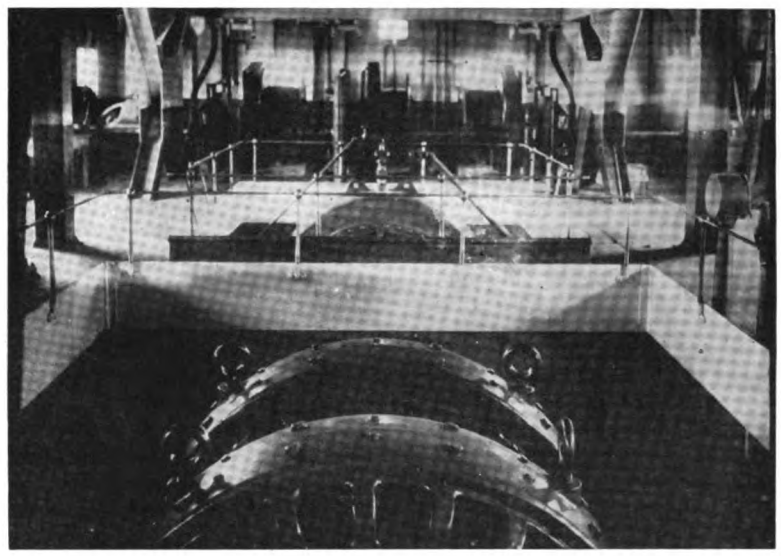
meet exacting operating conditions. These specifications covered in great detail, the capacity requirements for the dredge, but in order to obtain the most favorable price, together with the best design, the proposals required each bidder to submit his own designs and detailed specifications, to meet all the requirements of the Canal specifications.

Bids and plans were received from the largest dredge builders in the United States, and after they had been carefully examined, the Canal officials awarded the contract for this mammoth dredge to the Ellicott Machine Corporation, as their bid was considered lowest in price, meeting all the requirements of the Canal specifications to the best advantage.

The Diesel-electric hydraulic dredge consists essentially, of a suction pump, driven by an electric motor with power furnished by Diesel generators; an agitating ladder, usually built of steel, carrying a revolving cutter at its lower end for loosening material. The suction pipe from the dredging pump leads down this ladder to a point near the revolving cutter head and the discharge line leads from the pump to the stern of the dredge, and is connected to a flexible floating discharge line leading to shore. The material is then conveyed through additional pipe to the desired point of final discharge.



View looking aft shows two of the main engines. Note the substantial structure and traveling crane for use in making repairs.

Dredge Las Cruces

The dredge LAS CRUCES is of the Diesel-electric type. Four Fulton Diesel engines are directly connected to generators and form the main power units, while the main pump and all auxiliaries are driven by electric motors. The dredge will be capable of pumping through a pipe line over two miles in length, and will have a capacity of 500 to 1,000 cu. yd. per hour, depending upon the kind of material dredged. With shorter pipe lines, the capacity will be correspondingly increased. The displacement in working condition will be about 2500 tons.

The canal channels, especially through the Gaillard Cut, (which is 300 ft. in width), are rather constricted for maintaining dredging work which must be carried on in the face of traffic, and the danger of collision ever present. The hull, which has a length of 226 ft., width of 50 ft. and depth of 14 ft., is built with watertight compartments all around, any two of which can be flooded without endangering the dredge. In addition, both engine rooms and the motor room have a double bottom, 2½ ft. deep, thus making it practically unsinkable.

The shell plating of the hull is exceptionally heavy, being 5 lb. per sq. ft. heavier than required by American Bureau of Shipping rules. The hold is divided into two engine rooms, a motor room and a pump room. On the port side, from the pump room aft, the watertight compartments have a water-tight flat about 4 ft. 6 in. below the main deck, forming a trough for the discharge pipe. The strake of the deck plating directly above the discharge pipe is hinged, so that the discharge pipe is at all times accessible for inspection or turning. The trough is also provided with scuppers to take care of any ordinary leakage, but should a pipe burst, and the trough fill up, the water and material would immediately flow out through the hinged deck plating or trough covers and overboard and not flood the dredge.

Great care was taken in the design of the foundations for the main engines and generators. These consist of 30 in. I-beams, secured to the girders in the double bottom, all riveted to transverse members. In addition to this rigid construction, two structural steel truss frames extend from end to end of the hull, the forward ends extending out and acting as supporting frames for the ladder, while the after ends are tied in to the spud frame. The height of these trusses is 33 ft. above the bottom of the hull, spaced 11 ft. from the center line. The spud frame extends to a height of 86 ft. above the main deck, in order to lift the spuds from the top, and eliminate spud hoist trouble by the jamming of rocks between sheaves and cable hoist, experienced when sheaves are installed for that purpose in the bottom of a spud.

The hoisting and swinging machinery is on the main deck forward, just inside the main deck house. Next aft of this is located the main pump, the shaft of which passes through a watertight bulkhead into the main motor compartment, where the double armature 2500 s.hp. motor is located. Just aft of this, and separated from it by a watertight bulkhead, is the forward engine room, with two of the main engines and their main and auxiliary generators. The after engine room contains the other two main engines together with their generators. On the main deck aft, just inside the main deck house, is located the spud hoisting machinery with its motor. The truss was paneled on the starboard side so as to locate the main switchboard on the main deck, midway between the two engine rooms. On the opposite side the truss was paneled in a similar manner giving a large opening through which heavy parts may be handled.

There are two spuds each 42 in. sq. and 92 ft. long, capable of holding the dredge when working in 60 ft. of water. Due to the extreme depth of water and the swift current, together with the wind pressure on the dredge, the design of the spuds was a matter of extreme importance, and provides that the fibre stress in working condition is about the same for the full length, irrespective of the depth of water. Each spud is provided with a cast steel spud point at the bottom and two lifting sheaves at the top. The weight of each spud is about 110,000 lbs. They are held in place by steel spud wells, built into the stern of the hull and provided with hinged gates which may be opened without drydocking, so that the spuds may be easily removed.

The steel lower house, extending from the ladder well to near the stern, is 12 ft. high and 36 ft. wide. At each side steel brackets and columns carry a 10 ton trolley beam extending from the pump room to the 10 ton jib crane near the stern. Two 10 ton travelling cranes take care of the two engine rooms and pump room.

Accommodation for Personnel

Quarters are provided for a crew of 80 men. The house for the living quarters is built of steel, and is divided into forward and after sections. The forward end is known as the gold quarters—quarters for white American citizens,—while the after end will be used for the silver quarters,—quarters for colored alien laborers. There are 10 separate staterooms for the officers, all equipped with berths, settees, lockers, basins, etc. The after house is divided into two compartments, fitted out with berths and lockers for the crew. All rooms are equipped with electric lights and fans, and all doors and windows are bronze screened.

The galley is equipped with a Westinghouse double electric marine range, with dressers, dish racks, sink and all necessary equipment required for the galley. Adjoining the galley there is a cold storage room, about 7 ft. x 12 ft. and a chill room, 4 ft. x 7 ft. for the preservation of meats and vegetables. The proper temperature is maintained by two ton motor driven ice machines located on the main deck, each driven by a 5 hp. 215 r.p.m. motor directly connected by means of a flexible coupling.

The dredging pump has a 26 in. suction opening with a 24 in. diameter discharge, and a clear opening of 18 in. through the runner. The pump shaft is 11¾ in. diameter threaded on the runner end, making the runner easily removable. The weight of the runner is carried on a ring oiling babbitted bearing with a renewable babbitted shell liner. The thrust of the pump is carried by a Kingsbury thrust bearing with a steady bearing at one end. A Falk-Bibby flexible coupling connects the pump shaft to the motor of 2,500 s.hp.

The average of the maximum ranges of the tide on the Pacific side of the Canal is about 20 ft. It is desired to dig to a depth

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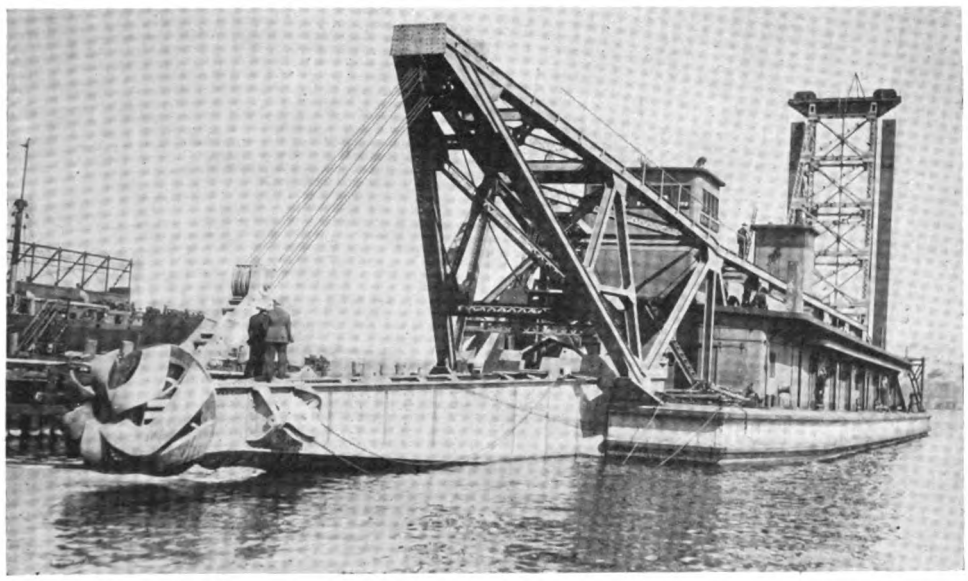

The ladder may be lifted clear of the water to facilitate repair of the suction pipe

of not less than 40 ft. at low tide so the ladder must be capable of digging to a depth of 60 ft. at high tide. To dig hard material at this depth and in sufficient quantity for a dredge of this power, a cutter ladder of huge proportions and strength was designed. The ladder, 90 ft. in length complete with its motor weighs nearly 400,000 lbs. The side girder beams are built up of ⅝ in. steel plates at top and bottom. Cross members at the after end are built of structural steel, while for the forward end they are steel castings. To make the ladder rigid in a transverse direction, stringer plates are riveted to the side members, with angle crossbracing.

In order for the operator to know to what depth the ladder is digging, and at what depth the spuds are, depth gauges operated by Selsyn motors are installed in the operating room.

Provision for Repair

To facilitate its repair or replacement the suction pipe is kept on the ladder above the water line when the ladder is in its upper position. The ladder trunnion bearings, therefore, are secured about midway between the top and bottom girder beams.

The cutter shaft is 10 in. in diameter, except where it passes through the suction head, where it is increased to 11 in. The suction head is a very heavy steel casting secured to the main girder beams. The disc around which the cutter revolves is 6 ft. 9 in. in diameter, with renewable wearing rings. The cast iron bearing bushing in the suction head is 4 ft. 6 in. long with a water jet stuffing box connection on the inboard end, so that the bearing will at all times be kept free from grit. The cutter is of the six bladed one piece spiral type, attached to the squared end of the shaft by a cross key. The bearings for the cutter shaft are carried on top of the cross members, so the shaft can be removed from the top. This avoids carrying the weight on the bearing caps.

All suction and discharge pipe is made of cast steel. At the ladder trunnion a special ball joint is installed, so as to avoid unnecessary bends in the suction line and also to provide for an exceptional digging range. In the discharged line Victaulic joints are used instead of flanged connections to cut down repair expense and so that pipe can be easily turned. Instead of the usual pontoon connection at the stern, consisting of rubber sleeves and nipples, a steel swivel elbow is provided, allowing a swing of 90 deg.

At the forward end of the hull, three 30 in. flanged hoisting drums are provided, one for lifting the ladder and two for swinging the dredge, and arranged for 1¼ in. diameter wire rope. Two similar drums aft provide for lifting the spuds. This machinery is driven by a 100 hp. motor, through gearing to a lay shaft 5 in. in diameter on which are mounted the pinions and friction clutches. The drums are mounted on separate shafts running in babbitted bearings, with the driving gears bolted directly through the drum flanges. All gears are of steel with cut teeth.

Both the forward and aft hauling machinery is controlled hydraulically from a system of levers in the operating room. The spud machinery may also be operated from the after end of the dredge thus providing convenience of operation and safety of the plant.

Four 911 b.hp. Fulton Diesels (see page 939 April MOTORSHIP) make up the main power plant. These engines are 8 cyl. 4 cycle, single acting, trunk piston, air injection type and operate normally at 204 r.p.m. Each engine is directly connected to one main and one auxiliary direct current Westinghouse generator with armatures mounted on a common shaft.

Electrical Equipment

All electrical equipment conforms to "General Specifications for Electrical Appliances on Shipboard," No. 100-B, as issued by the corps of Engineers, U.S.A., 1925, with but few exceptions. All motors and generators, switchboard, and other electrical appliances were furnished by the Westinghouse Electric & Manufacturing Co.

The main generators are rated 550-305 kw., 40 deg. continuous, 270-250 volts, compound wound, 204 r.p.m., separately excited from 240 volt bus, while the auxiliary generators are rated 220 kw., 40 deg. continuous, 120 volts, 204 r.p.m., shunt wound, self excited.

The main pump motor is rated 2500 b.hp. 974 volts, 230-325 r.p.m. The unit is of double armature type, 487 volts per armature, compound wound, naturally ventilated and separately excited at 240 volts; excitation being secured from the auxiliary generators. The double armature type was selected so that either armature could be operated alone, in case of failure of the other. The main pump motor control consists essentially of a motor field rheostat, and gives complete control of the motor in very small increments from zero to the full speed.

The main switchboard on the main deck, starboard side, midway between the forward and after engine room occupies a fore and aft length of approximately 23 ft. It consists of a total of 12 panels of the dead front safety type, and is built of 2 in. ebony asbestos, with a marine finish.

Each main generator and each auxiliary generator has an individual control panel, with a complete set of instruments for registering the current and volts under operating conditions, and a specially designed set-up switch, so that various combinations of main and auxiliary generators can be used. The set-up switches are so interlocked that it is impossible to make an incorrect set-up for supplying power to the main pump motor and auxiliaries.

One panel with the proper instruments and set-up switches is for the control of the main generators and dredge pump motor circuit. The other panels make up the control for the feeder circuits supplying power to the various auxiliary motors, such as cutter motor, hauling and hoisting motor, spud hoist motor, fire pump motor and various smaller motors.

To Check Power Expended

Provision is also made for the installation of three graphic recording wattmeters, one on the main pump, one on the hauling winches and one on the 240 volt bus. By this means, an absolute check can be had at all times on the consumption or waste of power expended.

One panel of the switchboard takes care of auxiliary equipment. Two auxiliary or emergency Worthington Diesels direct connected to two 40 kw. 115-230 volt, 500 r.p.m. generators are located on the main deck. They operate in parallel and may be used to carry the auxiliary load independent of the main generators, allowing the full main generator power to be thrown into the pump, or when this is not required, and only two or three prime movers are being used, the auxiliary load may be thrown on to the main generators and the emergency set or sets can remain idle. Working jointly, the two sets are capable of raising the spud or ladder and one can operate the machine shop and lights.

In general, the switchboard has been designed to take care of every useful condition of operation of the main and auxiliary units, shore power emergency lighting, emergency generating, minor auxiliaries and machine tools in a safe and efficient manner. Provision is also made for supplying power to the electric ranges.

Mounted on the ladder, 350 hp. cutter motor drives the cutter thru spur reduction gears and operates at 300-500 r.p.m. A drip proof master drum controller provides three point armature control and 12 point field control and cutter speeds from 12 to 20 r.p.m. may be obtained.

The 100 hp. motor for the ladder hoist and swinging winch is located on the main deck forward, connected thru gearing with

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the ladder hoist and swinging drums. Its control is of the variable voltage type. Eight speeds are obtained by generator field resistance and two speeds are obtained by motor field resistance. The controller is mounted in the pilot house with the necessary contacters and protective relays mounted in the control room underneath the pilot house. Emergency reversing is obtained by reversing the motor excitation.

The spud hoist 100 hp. mill type motor is located on the main deck aft, connected by gearing to the hoisting drums, for raising and lowering the spuds. Two nonreversing drum controllers control it, one of which is mounted near the motor together with a transfer switch, and another mounted in the pilot house, permitting operation from either location. A 50 kw. 3 unit, 3 wire, motor generator set with balance coils and motor control, is provided to furnish power for lights and machine tools as well as when plugged in from shore or when operating off the auxiliary bus.

All the following motors and controls, mentioned for use with the auxiliaries, are of the marine type, totally enclosed construction, and each control is in a weatherproof cabinet, complete with overload and low voltage protection with a waterproof push button.

Auxiliary Equipment

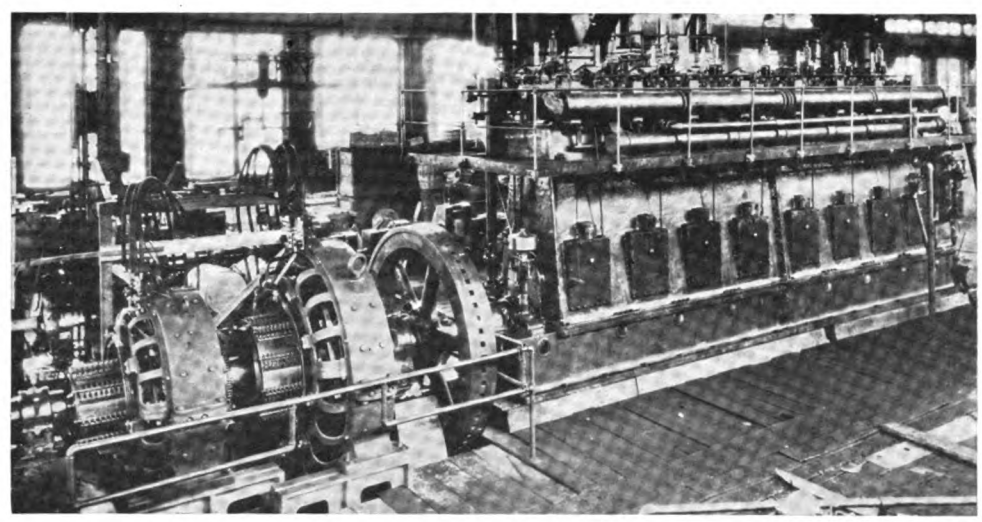
An auxiliary air compresor driven by a 7½ hp., 400 r.p.m. motor with automatic pressure gauge control, is installed for pumping the air bottles for the main engines up to 1,000 lb. pressure. These air bottles are normally filled from the compressors attached to the main engine.

Two circulating pumps, one in each engine room, supply water for the main engines. Each pump is of sufficient capacity to care for all four engines. The motors for driving these pumps are of 15 hp. at 1150 r.p.m., with push button automatic control. A motor driven centrifugal fire pump of 800 gallons capacity, 100 lb. pressure, is located in the forward engine room and piped to the various fire plugs. A 75 hp. 1750 r.p.m. motor operates this pump.

Two 3 in. two stage service pumps, one in each engine room, are piped interchangeably, each having a capacity of 100 gal. against a head of 200 ft., for supplying water to the ladder suction head, ball joint, sealing ring and main pump stuffing box. The motors for these pumps are 15 hp. 1700-1800 r.p.m.

The pump for supplying pressure for the hydraulic operating gear is similar to the service pumps, and is provided with a 15 hp. compound wound, 230 volt, 1700-1800 r.p.m. motor. Two automatically regulated fresh water and sanitary pumps supply water to the living quarters. The motors for these pumps are 5 hp., 1750 r.p.m. with automatic control.

An 8 x 12 in. horizontal duplex double acting plunger type bilge pump is piped thru manifolds to all the watertight compartments in the hull and driven thru reduction gears by a 7½ hp. 575-1150 r.p.m. motor. For filling oil bunkers and for transferring oil to the various fuel oil tanks a rotary motor driven pump is furnished. This pump has a capacity of 100 gal. against a total head of 100 lb. per sq. in., and is driven by a 15 hp. compound wound, 900 r.p.m. motor with automatic control. A small rotary, motor driven pump is supplied for filling the lubricating oil tank and sump tanks, and is driven by a 1½ hp., 1150 r.p.m. motor.



One of the four Diesel-electric generating units ready for shipment from The Fulton Iron Works.

In addition to the auxiliary pumps mentioned above, one sump pump and eight centrifuge pumps are provided. At the base of the main pump, a sump or depression was made with a siphon arrangement operating from the bottom of the sump to the suction side of the main pump. The purpose of this installation is to take care of water and debris which may be thrown into the bilge when manhole plates are open for the extraction of rock or for any other purpose. This will operate, ot course, only when the main pump is running.

The machine tool outfit, all directly connected to individual motors, includes one Rockford shaper, one Greaves Klusman lathe, one Rockford drill press, one radial drill and one Greenfield bolt cutter.

Clean Oils Assured

Centrifuges are provided for both lubricating and fuel oils. Two De Laval No. 360 lubricating oil purifiers are driven by 2 hp., 1750 r.p.m. Westinghouse motors and hooked up with ¾ in. rotary pumps, which are driven by ½ hp. motors. One centrifuge unit is located in each engine room. Two No. 600 De Laval fuel oil purifiers are located on the main deck.

Past practice on other equipment proved the economy in assuring clean lubricating oils to Diesel engines. Experience has also convinced us that the centrifuging of even the higher grades of fuel oil was economical practice, and the possibility of having to use a much inferior fuel oil because of remoteness of our location from supply and possible isolation, made this installation a necessity. The fuel oil and water carried in compartments on each side of the hull is sufficient for 30 days operation.

On August 27, 1928, the preliminary tests required of the contractor to theoretically determine the output of the LAS CRUCES, was made at the plant of her builders, the Ellicott Machine Corporation in Baltimore, Md. This test was made by the "nozzle method" and the conditions to be met were that the dredge should be able to operate for at least an eight hour period against a head equivalent to the resistance of 5280 ft. of 24 in. discharge pipe line, the output to be 2200 cu. ft. per min., of a mixture of water and solids with an average density of 75 lb. per cu. ft. The friction head at this output to be assumed at 2.5 ft. per 100 ft. of discharge pipe. These preliminary tests were satisfactorily met by the builders. As anticipated in the original calculations, the output of the LAS CRUCES, judging from preliminary tests, may be expected to more than double that of our most powerful steam dredge No. 86 and relay booster.

The dredge is now fitted for the ocean trip, from Baltimore to Cristobal, Canal Zone. Two powerful sea-going tugs will perform the towing. Her arrival in the Canal Zone is anticipated by the first of the year, to immediately undergo a final operating test of 60 days.

Acknowledgment should be made in closing, of the painstaking and expeditious inspection work performed by the Washington office of the Panama Canal, under the direction of Mr. A. L. Flint, the Chief purchasing officer and his chief inspecting engineer, Mr. A. E. Doying. Also of the work performed by Mr. C. H. Johnson of Mechanical Division, inspector of the hull and Mr. B. E. Swain, inspector of machinery installation, who were assigned to the Washington office for this work from the Canal Zone.

Personal

John A. Manley, for the past three years, manager of sales development for Fairbanks, Morse & Company of Chicago, has been elected vice president in charge of sales according to a recent announcement of the Board of Directors. Mr. Manley, was formerly manager of accounts for the advertising agency of Henri, Hurst & McDonald also of Chicago.

O. Nonnenbruch has been appointed Chief Engineer of Oil Engines with the De La Vergne Machine Company, now a part of the Cramp-Morris Industrials, Philadelphia.

F. Edward O'Neil has been elected Vice President and Manager of the Fulton Iron Works, St. Louis, Missouri and will have full charge of the company's Diesel and gas engine business, according to a recent announcement of the company. For the past eleven years he has been in charge of the New York office.

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Norfolk to Have Diesel-Electric Ferry

New 800 b.hp. Steel Ferryboat for Norfolk-Portsmouth Route Will Have Capacity for 40 Autos and 200 Passengers

A NEW Diesel-electric ferryboat building at the plant of the Spear Engineers Inc., Norfolk, will be placed in service on the present route of the Norfolk Ferries Company between Norfolk and Portsmouth, Virginia. It is expected that she will be completed and ready for service by the summer of 1929. The Diesel engines are being built by the Bessemer Engine Company and the electrical machinery is under construction by the General Electric Company; Eads Johnson of New York is responsible for the design.

The new boat will have an overall length of 173 ft., and beam of 57 ft. The power plant will consist of two Diesel engines, each rated 400 b.hp. at 250 r.p.m., direct connected to two 270 kw. 250 volts main generators and to two 30 kw. 250 volts exciters, one for each generator. The main generators will be shunt wound, and the exciters will be compound wound.

The main propulsion motor will be designed for a continuous rating of 650 horsepower at 185 r.p.m., and will be of the double-armature type, shunt wound, operating on direct current and arranged for separate excitation at 125 volts. Each armature will operate at 250 volts.

Pilot house control of the propulsion motor will be by the Ward Leonard system of variable voltage, allowing speed variations from maximum to minimum. The control switchboard will be of the dead-front type, consisting of three panels. Mounted on each of two panels will be equipment for controlling the operation of each of the main generators, and the third panel, will carry devices for engine room control of the propulsion motor. A switchboard of the live-front type will control the operation of the two exciters, and of six auxiliary power circuits of sufficient capacity for the steering gear and engine room auxiliaries. A ten-circuit panel-board will govern the lighting circuits.

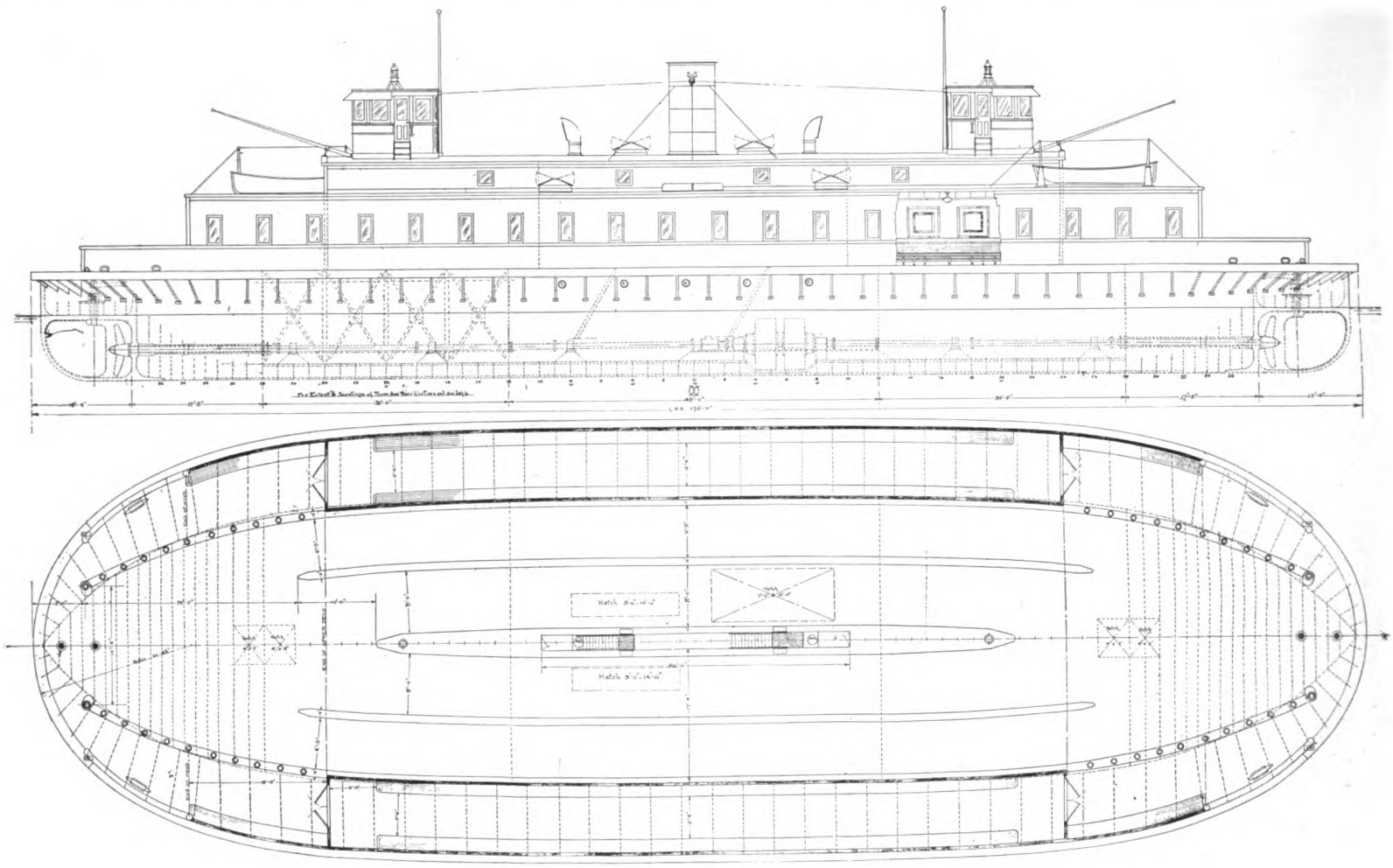
In operation, the two main generators will form a continuous series circuit with the two motor armatures. By means of selector switches it will be possible to connect the generators into the series propulsion circuit, or to complete the propulsion circuit without the use of any one generator.

Auxiliaries including an air compressor, rotary fire and bilge pump, steering gear, etc., are operated electrically and electric heaters will be used in the pilot houses.

An electrical steering motor at each end of the boat is controlled from the pilot houses, and the steering gear is so arranged that it is instantaneously changeable from power to hand operation.

An unusual feature of the machinery arrangement is that there will be no auxiliary engine. All of the electrically operated auxiliary units when used for emergency lighting and pumping, will receive current from a motor generator supplied by a shore connection when the main engines are not in use.

The hull of this ferry boat will be divided into five water-tight compartments by four watertight bulkheads. The main deck and cabins on each side will be of wood on steel framing, the upper deck of wood on steel beams and the pilot houses entirely of wood.



Side elevation and main deck plan of Diesel-electric ferry to enter service next summer.

Length overall	173 ft. 0 in.
Length b.p.	146 ft. 6 in.
Beam overall	57 ft. 0 in.
Beam of hull at deck	37 ft. 0 in.
Depth molded	14 ft. 0 in.
Draft	8 ft. 6 in.

Seating capacity for about 200 passengers is provided in each of the cabins, and the vehicular gangways will accommodate approximately 40 cars.

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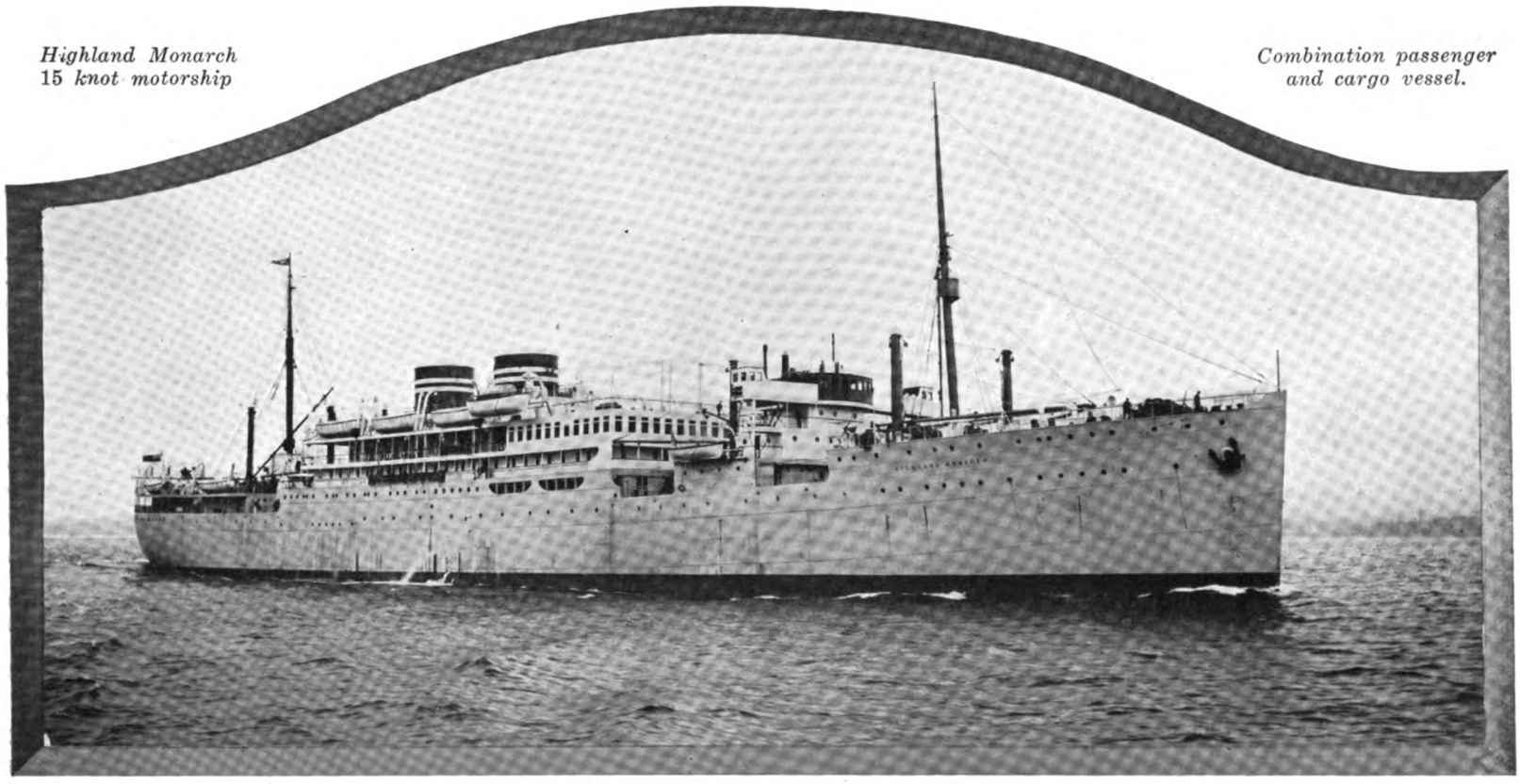

Highland Monarch
15 knot motorship

Combination passenger and cargo vessel.

World Standard of Fast Freighters Moves Up to 15 and 16 Knots

Foremost Shipping Companies Are Ordering New Motorship Tonnage Superior to the Standards of Steamer Construction

By R. W. Crowly

FAST freighters now make 15-knot passages on full draft. Next year they will make 16 knots under similar conditions. The idea that the 14-knot freighter is fast now belongs with the Model T Ford—it has gone out of date. Yet, paradoxically, this means that 14-knot freighters will be constructed in larger numbers than before. The business world has a law of relativity, under the ordinance of which the lower grades step along in rhythm with the highest grade. Thus, when the leaders increase their speed from 14 knots to 15 knots and even to 16 knots, those who held to second rank at 12 knots must step up to 13 knots or to 14 knots if they intend to hold the grade, or in default will be passed by new aspirants, and so on down the line. Actually in every decade of shipping there are honored names that descend the scale and new ones that rise up.

To adjust the mind to the new speed standard of the fast freighter the best corrective is a study of the shipbuilding list on the next page presenting in table form the fast freighters under construction in the shipyards of the world on the first day of last September. The 14-knot boats of over 5000 s.hp. are included for comparison, but the 14-knotters below 5000 s.hp. are omitted, even though their exclusion has shut out a number of vessels making that speed on 4600 s.hp.—4800 s.hp. A line has to be drawn somewhere in order to keep the list within a length that can be conveniently scanned, and 5000 s.hp. serves well as the boundary.

Whoever thinks that this progress is no concern of America's deludes himself. The four big 16-knot Prince Line freighters constituting the bid of Furness, Withy & Co., for the cream of the trade between the United States, Brazil and Argentine, will cut into the business of the Munson Line, which makes about the same speed with its combination steamers and it will add further depreciation to the sailings of the American Republics Line. Wonderful vessels these new Prince liners will be, measuring about 10,000 tons gross and driven by two powerful double-acting engines aggregating over 10,000 s.hp. Preceding them in service will be the two 16-knot motorships to be introduced by Garcia & Diaz, who in the last few years have built up a big connection on the New York-South American berth with their snappy motor-vessels.

The contract for the two 16-knot Garcia & Diaz boats gave the first notice of increased speed in this trade, and Sir Frederick Lewis, chairman of Furness, Withy & Co.,—who is going very strong on big fast motorships—quickly decided to match the higher speed in bigger vessels and more frequent sailings. That will not be the end. To the contrary, it is only the beginning. Other foreign lines will improve their equipment gradually in self-defense. What more likely, for instance, than that Lamport & Holt, who have never lagged in the 80 years or so they have been on this run, will order fast motor-vessels for the service, now that their steamer business is confronted by such competition? The higher speed is going to pinch all those who discount its effect on their business, and the lines which the Shipping Board has set up in the East Coast trade between North and South America are going to experience harder sledding. The American lines must keep pace with the improvement or follow the slow decline that led so many of their predecessors to the mudflats and oblivion. From those alternatives there is no escape. Vessels that are outclassed pass to lower grades each year until they become the ragtag and bobtail of the ocean.

South America today is standing high in the favor of shipping leaders of all nations and is receiving the benefit of faster and superior transportation to and from all parts of the world. In the U. K.-South America services the Houlder Line inaugurated 15-knot freighter passages three years ago with UPWEY GRANGE, and has since followed with DUNSTER GRANGE and EL ARGENTINO. For the same run the Nel-

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Building List of Powerful Twin-Screw Motor Freighters of 5000 S.hp. and Over

Every care has been exercised in the compilation of the figures, but reports of new construction must always be recognized as forecasts subject to change

Name of Ship	*Speed Knots*	*Shipowner*	*Length*	*Breadth*	*Depth*	*Gross Tons*	*Engines*	*Power S.hp.*
3—Maru	16	Nippon Yusen Kaisha.....	510 ft. 0 in.	66 ft. 0 in.	41 ft. 0 in.	12,000	B. & W.....	11,000
Maru	16	Nippon Yusen Kaisha.....	510 ft. 0 in.	66 ft. 0 in.	41 ft. 0 in.	12,000	B. & W.....	11,000
Maru	16	Nippon Yusen Kaisha.....	510 ft. 0 in.	66 ft. 0 in.	41 ft. 0 in.	12,000	B. & W.....	11,000
For the Seattle service. Not to be confused with the 18 knot passenger liners ordered by the N. Y. K.								
4—Northern Prince...	16	Furness, Withy & Co.....	496 ft. 3 in.	64 ft. 10 in.	26 ft. 6 in.	10,000	H. & W. d. a.....	10,500
Western Prince....	16	Furness, Withy & Co.....	496 ft. 3 in.	64 ft. 10 in.	26 ft. 6 in.	10,000	H. & W. d. a.....	10,500
Southern Prince...	16	Furness, Withy & Co.....	496 ft. 3 in.	64 ft. 10 in.	26 ft. 6 in.	10,000	H. & W. d. a.....	10,500
Eastern Prince....	16	Furness, Withy & Co.....	496 ft. 3 in.	64 ft. 10 in.	26 ft. 6 in.	10,000	H. & W. d. a.....	10,500
3—Rangitiki	15	New Zealand S.S. Co.....	525 ft. 0 in.	70 ft. 0 in.	.....	12,500	Brown-Sulzer	10,000
.....	15	New Zealand S.S. Co.....	525 ft. 0 in.	70 ft. 0 in.	.....	12,500	Brown-Sulzer	10,000
.....	15	New Zealand S.S. Co.....	525 ft. 0 in.	70 ft. 0 in.	.....	12,500	Brown-Sulzer	10,000
5—Highland Chieftain	15	H. & W. Nelson, Ltd.....	523 ft. 3 in.	69 ft. 0 in.	35 ft. 9 in.	12,000	H. & W. d. a.....	10,000
Highland Monarch.	15	H. & W. Nelson, Ltd.....	523 ft. 3 in.	69 ft. 0 in.	35 ft. 9 in.	12,000	H. & W. d. a.....	10,000
Highland Brigade.	15	H. & W. Nelson, Ltd.....	523 ft. 3 in.	69 ft. 0 in.	35 ft. 9 in.	12,000	H. & W. d. a.....	10,000
Highland	15	H. & W. Nelson, Ltd.....	523 ft. 3 in.	69 ft. 0 in.	35 ft. 9 in.	12,000	H. & W. d. a.....	10,000
Highland	15	H. & W. Nelson, Ltd.....	523 ft. 3 in.	69 ft. 0 in.	35 ft. 9 in.	12,000	H. & W. d. a.....	10,000
2—Sud Americano....	16	Linea Sud-Americana.....	460 ft. 0 in.	60 ft. 4½ in.	30 ft. 0 in.	8,100	Deutsche Werke d. a.	8,400
Expresso	16	Linea Sud-Americana.....	460 ft. 0 in.	60 ft. 4½ in.	30 ft. 0 in.	8,100	Deutsche Werke d. a.	8,400
Magdalena	15½	Hamburg-Amerika P. A. G.	456 ft. 8 in.	61 ft. 0 in.	31 ft. 2 in.	9,450	Sulzer	8,000
Sister ship Orinoco in service								
Staffordshire	15	Bibby Line	502 ft. 0 in.	62 ft. 0 in.	36 ft. 3 in.	10,200	Sulzer	7,700
Sister ships Cheshire and Shropshire in service								
Manunda	15½	Adelaide S.S. Co.....	430 ft. 0 in.	60 ft. 0 in.	29 ft. 6 in.	.....	H. & W. d. a.....	7,500
Karamea	15	Shaw, Savill & Albion Co.	481 ft. 0 in.	64 ft. 0 in.	30 ft. 8 in.	9,300	Sulzer	7,450
Sister ships Zealandic, Taranaki and Coptic in service.								
General Osorio.....	15	Hamburg-Amerika P. A. G.	492 ft. 0 in.	65 ft. 0 in.	36 ft. 7 in.	.....	M. A. N. d. a.....	7,200
.....	15	Union Castle Mail.....	470 ft. 0 in.	61 ft. 0 in.	42 ft. 0 in.	.....	H. & W. d. a.....	7,000
2—Port Alma.....	14½	Commonwealth & Dominion.	475 ft. 0 in.	63 ft. 0 in.	43 ft. 4 in.	8,250	Doxford	6,500
Port Fairy.....	14½	Commonwealth & Dominion.	475 ft. 0 in.	63 ft. 0 in.	43 ft. 4 in.	8,250	Doxford	6,500
Sister ships Port Fremantle, Port Gisborne and Port Huon in service.								
2—Maru	14½	Osaka Shosen Kaisha.....	.....	.....	.....	9,400	Sulzer	6,400
Maru	14½	Osaka Shosen Kaisha.....	.....	.....	.....	9,400	Sulzer	6,400
2—.....	14½	Alfred Holt & Co.....	452 ft. 0 in.	59 ft. 0 in.	35 ft. 3 in.	7,900	B. & W.....	6,000
.....	14½	Alfred Holt & Co.....	452 ft. 0 in.	59 ft. 0 in.	35 ft. 3 in.	7,900	B. & W.....	6,000
2—.....	14½	Furness, Withy & Co.....	442 ft. 0 in.	60 ft. 0 in.	27 ft. 7 in.	.....	Doxford	6,000
.....	14½	Furness, Withy & Co.....	442 ft. 0 in.	60 ft. 0 in.	27 ft. 7 in.	.....	Doxford	6,000
2—Eridan	14½	Messageries Maritimes.....	464 ft. 0 in.	61 ft. 2 in.	37 ft. 0 in.	.....	Sulzer	6,000
Jean Laborde.....	14½	Messageries Maritimes.....	460 ft. 0 in.	.....	.....	.....	Schneider	6,000
.....	14½	Cie. Générale Transat.....	.....	.....	.....	.....	M. A. N. d. a.....	6,000
8—T.....	14½	Wilhelm Wilhelmsen.....	460 ft. 0 in.	60 ft. 4 in.	31 ft. 7 in.	6,750	M. A. N.....	5,500
T.....	14½	Wilhelm Wilhelmsen.....	460 ft. 0 in.	60 ft. 4 in.	31 ft. 7 in.	6,750	M. A. N.....	5,500
T.....	14½	Wilhelm Wilhelmsen.....	460 ft. 0 in.	60 ft. 4 in.	31 ft. 7 in.	6,750	M. A. N.....	5,500
T.....	14½	Wilhelm Wilhelmsen.....	460 ft. 0 in.	60 ft. 4 in.	31 ft. 7 in.	6,750	M. A. N.....	5,500
T.....	14½	Wilhelm Wilhelmsen.....	460 ft. 0 in.	60 ft. 4 in.	31 ft. 7 in.	6,750	Deutsche Werke....	5,500
T.....	14½	Wilhelm Wilhelmsen.....	460 ft. 0 in.	60 ft. 4 in.	31 ft. 7 in.	6,750	Deutsche Werke....	5,500
T.....	14½	Wilhelm Wilhelmsen.....	460 ft. 0 in.	60 ft. 4 in.	31 ft. 7 in.	6,750	Deutsche Werke....	5,500
T.....	14½	Wilhelm Wilhelmsen.....	460 ft. 0 in.	60 ft. 4 in.	31 ft. 7 in.	6,750	Deutsche Werke....	5,500
Sister ships Talleyrand and Ta onga in service.								
Westralia	14	Huddart, Parker & Co.....	449 ft. 0 in.	60 ft. 0 in.	33 ft. 6 in.	8,400	H. & W.....	5,000
Parrakoola	14	Transpacific S.S. Co.....	435 ft. 0 in.	57 ft. 0 in.	39 ft. 10 in.	9,000	Gotaverken	5,000
Sister ship Mirrabooka in service.								

son Line is now building a fleet of 15-knot freighters to be driven by double-acting Diesel engines of the Harland & Wolff type similar to those for the Prince Line vessels. Norway, Germany, Italy and Japan have in the last few years all built freighters of 14 knots full displacement speed for the South American trade, West coast as well as East coast.

Only one bright spot shows in this country's operations to that part of the world. W. R. Grace & Co. have earned 100 per cent credit by their decisive advance to the forefront of present day shipping practice in establishing a 16-knot service to the West coast of South America with their two new 9000-ton vessels, SANTA BARBARA and SANTA MARIA, which, though having sizeable passenger accommodation are very dependent on freight. By this step they have made themselves eligible for membership in the Nulli Secundus Club, to which only world leaders can belong. Apart from the Grace Line's progress this country has stood still while the foreign lines went ahead.

Can anybody believe that even the best selection of our wartime freighters makes as good a showing now against foreign competition as it made in 1920? At the time of building it was no more up-to-date than the 1914 designs of Europe, and if you would know how it rates today look at

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Building List of Powerful Single-Screw Motor Freighters of 5000 S.hp. and Over

Every care has been exercised in the compilation of the figures, but reports of new construction must always be recognized as forecasts subject to change

Name of Ship	*Speed Knots*	*Shipowner*	*Length*	*Breadth*	*Depth*	*Gross Tons*	*Engines*	*Power S.hp.*
4—Poelau Bras.....	15	Nederlandsche S. V. Mij...	490 ft. 0 in.	61 ft. 0 in.	36 ft. 9 in.	.....	Sulzer	7,040
Poelau Laut.....	15	Nederlandsche S. V. Mij...	490 ft. 0 in.	61 ft. 0 in.	36 ft. 9 in.	.....	Sulzer	7,040
Poelau Roebia.....	15	Nederlandsche S. V. Mij...	490 ft. 0 in.	61 ft. 0 in.	36 ft. 9 in.	.....	Sulzer	7,040
Poelau Telok.....	15	Nederlandsche S. V. Mij...	490 ft. 0 in.	61 ft. 0 in.	36 ft. 9 in.	.....	Sulzer	7,040
Portland	14	Hamburg-Amerika P. A. G.	468 ft. 0 in.	60 ft. 0 in.	29 ft. 4 in.	7,300	M. A. N. d. a.....	5,400
Sister ship Seattle in service								
2—Kota Baroe.....	14	Rotterdam-Lloyd Mij.....	467 ft. 6 in.	60 ft. 6 in.	33 ft. 6 in.	7,200	M. A. N. d. a.....	5,200
Kota Gedek.....	14	Rotterdam-Lloyd Mij.....	467 ft. 6 in.	60 ft. 6 in.	33 ft. 6 in.	7,200	Sulzer	5,200
Sister ships Kota Radja and Kota Inten in service								
5—Burgerland	14	Hamburg-Amerika P. A. G.	460 ft. 0 in.	60 ft. 0 in.	34 ft. 4 in.	.....	A E. G. d. a.....	5,100
Kulmerland	14	Hamburg-Amerika P. A. G.	460 ft. 0 in.	60 ft. 0 in.	34 ft. 4 in.	.....	A E. G. d. a.....	5,100
Leverkusen	14	Hamburg-Amerika P. A. G.	460 ft. 0 in.	60 ft. 0 in.	34 ft. 4 in.	.....	A E. G. d. a.....	5,100
Sauerland	14	Hamburg-Amerika P. A. G.	460 ft. 0 in.	60 ft. 0 in.	34 ft. 4 in.	.....	A E. G. d. a.....	5,100
Duisburg	14	Hamburg-Amerika P. A. G.	462 ft. 6 in.	61 ft. 0 in.	30 ft. 5 in.	.....	Sulzer	5,100
2—Saale	14	Norddeutscher-L'd D.S.A.G.	468 ft. 9 in.	59 ft. 9 in.	34 ft. 2 in.	.....	Sulzer	5,000
Spree	14	Norddeutscher-L'd D.S.A.G.	468 ft. 9 in.	59 ft. 9 in.	34 ft. 2 in.	.....	Sulzer	5,000
Courageous*	13	U. S. Shipping Board.....	457 ft. 4 in.	56 ft. 0 in.	35 ft. 2 in.	7,600	McIntosh & Seymour	4,000
Defence*	13	U. S. Shipping Board.....	457 ft. 4 in.	56 ft. 0 in.	35 ft. 2 in.	7,600	McIntosh & Seymour	4,000
Triumph*	13	U. S. Shipping Board.....	457 ft. 4 in.	56 ft. 0 in.	35 ft. 2 in.	7,600	McIntosh & Seymour	4,000

*Machinery consists of four engine-generator sets and single-screw electric drive.

the European vessels of 1914. They were nearly all steamers, just as our war built tonnage was, and now we count them slow, just as our war built vessels are, each in its trade. Europe has made great strides since the war. More than half the tonnage she now builds is motorshipping, and of the fast tonnage under construction probably 80 per cent is Diesel engined. It is just as if all our airplanes should be Jennies while Europe uses Fokkers and Junkers. We have definitely abandoned the Jennies in the air. Why let the nation be fooled with the Jennies of the sea, and why permit national funds to be borrowed for building more such Jennies?

Observe those 15-knot vessels of the New Zealand S. S. Co., with their remarkable five-cylinder single-acting Sulzer engines of 5000 s.hp. each, having cylinders 35 in. diameter; the 15-knot boats of the Shaw, Savill & Albion Co., in the same trade; the smaller 15-knot Dutch East Indies traders with more than 7000 s.hp. on a single shaft; the 15-knot boats of the Bibby Line in the Rangoon service; the 15-knotters for the Union Castle Line and for the Osaka Shosen Kaisha; and the 15½-knot vessels for the Hamburg-American Line and for the Adelaide S. S. Co. All of them are two knots or three knots faster than the 1920 boats. Only the vessels under construction are presented in the list, but in the last few years faster vessels have been built for all trades. Connect this list with the list of motorliners on order (*vide* MOTORSHIP, Sept. 1928, P. 748), and you will see the trend of shipbuilding throughout the world—ever towards faster and bigger vessels, mostly of the motorship type.

This trend is not new. The direction has been the same for ten years. In 1920 the Glen Line took delivery of the GLENAPP and GLENOGLE, the first two of four boats they had ordered of 9400 tons gross 4600 s.hp. and 13½ knots service speed at full draft. Their success was immediately apparent, and the same model was built by Harland & Wolff for the Royal Mail Steam Packet Co., and for the Holland-America Line, a total of 10 vessels from the same moulds and with identical machinery. (This was a notable example of production management of the highest order, conferring on the shipowners the benefit of an economy that American shipping firms rarely attempt to attain). These vessels were the first to be called 14-knotters, but there is a question whether they could actually average 14 knots on full displacement under the give and take of the weather on long passages. The speed of the 14-knot vessels shown in the building list on this page is unlikely to be challenged; it is definitely a sea speed of 14 knots at full draft, corresponding to an ordinary contract trial speed of, say, 15½ knots.

The 15-knotter made its debut in 1925 with LIMERICK, 8684 tons gross, 6000 s.hp. and UPWEY GRANGE, 9130 tons gross, 6400 s.hp. the former for the Union S. S. Co. of New Zealand and the latter for the Houlder Line, both with Sulzer type of machinery. It is questionable whether these vessels have a sea speed of 15 knots at full displacement, but on the other hand the 15 knots credited to the vessels on the adjoining list of vessels under construction is the sea speed to be maintained, and is the sort of 15 knots speed that will give rise to legends of 16½ knots and 17 knots.

Never before were these speeds used in the particular trades where they are now coming into vogue. Steamers never attained them, *nor are steamers now being built for them.* Motorships have made these speeds feasible, and the companies that are introducing them, have been guided in this progress by an apprenticeship in motorship operation or by an affiliation with companies that have learned the business in that way. The higher speeds have been attained in steps.

Furness, Withy & Co., for instance, started in 1912 with the 9-knot EAVESTONE, one of the very first Diesel-engined freighters that went to sea. Ill advised in the choice of machinery for that little boat, they were stung so badly that they left motorships alone until after the war and then in 1921 took delivery of DOMINION MILLER, now named PACIFIC COMMERCE, 5089 tons gross, 2500 s.hp., about 12 knots. This vessel they placed on the Pacific coast—U. K. berth. In 1924 they put into the service new vessels of 6300 tons gross with 2900 s.hp. In 1927 they increased the size and power of new boats to 6700 tons and 5000 s.hp., which assured 14 knots sea speed.

Meantime in the New York-Far East trade the same company had entered a fleet of 14½-knot freighters, ASIATIC PRINCE, CHINESE PRINCE, etc., 6400 tons gross, 5500 s.hp., forcing the Silver Line to build new vessels of comparable size and speed to supplant the first Silver Line boats that were only about 3 years old. For Furness, Withy & Co., this was another stage on the way to the 16-knot Prince Line vessels now on order for their North America-South America business.

Two other instances of the stages made by the various companies on their road to progress may be usefully cited. The Bibby Line, which started in 1921 with DORSETSHIRE and SOMERSETSHIRE, 7450 tons gross, 4500 s.hp. 13½ knots, now has vessels of 10,200 tons, 7700 s.hp. and about 15 knots. The Commonwealth and Dominion Line (a Cunard affiliation) began in 1925 with PORT HOBART and PORT DUNEDIN, 7500 tons gross, 5000 s.hp., about 13½ knots, and now builds vessels of 8250 tons gross, 6500 s.hp. and about 14½ knots.

This curtailed exemplification of the progressive steps that have led foreign shipowners to speeds of 15 knots and 16 knots emphasizes very clearly the passing of 14 knots as the first-class speed for freighters. That point is very important and should be noted, for the idea that 14 knots represents the peak of freighter achievement has just about become firmly rooted in domestic shipping circles, five years at least after it had been widely accepted abroad and at a time when it no longer holds true. I can remember that nine or ten years ago MOTORSHIP was calling attention to the trend towards a 14-knot speed, and in the last several years numerous references in this

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Port Fairy, a 14½ knot freighter of 8250 gross tons and powered with Doxford engines of 6500 s.hp. aggregate

magazine have indicated the tendency towards higher speeds than 14 knots.

Henceforth one must think of 16 knots full displacement speed as the standard of the fast freighter, but let this statement not be misinterpreted as an assertion that there is no place for the 14-knot freighter. When one spoke of 14 knots full displacement speed as the standard of the fast freighter it was not taken to mean that the 12-knot freighter was useless. There is freight for 14-knot vessels, for 12-knot vessels, for 10-knot vessels, and for even slower boats, but the best freight and the most freight will go into the holds of the 16-knot vessels—until they in turn are outspeeded.

There is a sound economic reason for the favor that shippers always give to the faster boats. Speed reduces the cost of financing shipments. World trade is done on credit. It may be the shipper's credit or it may be the consignee's credit, but a bank has to be paid for the use of the money lent, on whosever credit it may be, even though the bank hold the shipping documents. This money is generally computed at a cost of 6 per cent, although there are times when good credit costs less. Insurance may be reckoned at 2 per cent as an average. Count therefore 8 per cent for the credit and insurance. It does not seem much, but it soon runs into a considerable sum on even ordinary commodities.

Rubber, for instance, quoted in New York now around 20 cents a pound, is worth $450 per ton. Coffee stands at about the same figure. Tea is a little higher at 25 cents a pound, equal to $550 per ton. Vegetable oils from abroad range between 8 cents and 11 cents a pound or $180 to $250 per ton. Tin, of which our entire consumption has to be imported, sells at 48 cents a pound, equivalent to $1100 per ton. These are all base prices in the New York market during October, with variations above and below for superior or inferior grades. Prices at port of shipment of course are a little lower, but not so readily obtainable, and we may therefore take the New York prices to illustrate the cost of financing and insuring one ton of each of these commodities at the inclusive figure of 8 per cent.

For rubber and coffee the money constitutes a toll of 10 cents per ton per day or 70 cents per ton per week. For tea it is 12 cents per ton per day or 85 cents per ton per week. For vegetable oils, like cocoanut, soya, palm, etc., it is between 4 and 5 cents per ton per day or between 28 cents and 35 cents per ton per week. For tin it amounts to 25 cents per ton per day or $1.75 per ton per week. And for raw silk it rises to $2.50 per ton per day or $17.50 per ton per week.

This latter commodity we will single out because nearly everyone knows that super-express service, with armed guards, is given to raw silk crossing the continent from Seattle. Silk trains are run from the Pacific coast to the mills in the Eastern states on a faster schedule than passenger trains, because carloads of silk are so valuable. If silk be worth that speed on its overland passage is it not also plainly worth speed on the ocean passage? The same principle applies to all commodities, with greater or lesser effect according to the value. Really cheap commodities are not numerous. Ordinarily we regard cotton as cheap, but at 20 cents a pound it is worth $450 per ton. Compare this with coal at $5.50 per ton. Meat is quoted in Chicago at 15 cents to 25 cents per pound for dressed halves, which thus figure out at $350 to $550 per ton. For contrast, look at the distress price of fuel oil, worth about $7.00 per ton, when quoted at $1.00 per barrel. Gasoline may be taken at, say, $35.00 per ton.

Clearly both coal and fuel oil may move in any old slow boat without heavy charges for financing the shipment, but when one stops to think that a vessel of 10,000 tons dw.c. bound from the Orient for New York may have five, six or seven million dollars value on her manifest—and that is quite an ordinary occurrence—one's sense of proportion tells that this freight should be carried faster than a cargo of coal or fuel oil. When, for instance, the fast motorships of the Prince Line and Silver Line cut about a week from the passage between the East and New York they gave to shippers quite an appreciable saving in financial charges. Set a week's saving of the financing charges against the freight rate, and the proportion is always considerable, bigger of course the higher the value of the commodity.

Beyond this saving there is a factor of very great importance to all business houses, namely, that the faster the credit operations can be completed the greater the use they can make of their line of credit during the year, thus reducing the capital required for a given volume of business. This is the factor that has spurred domestic transportation to increased speed during the last decade. Materials are now generally purchased on short order for quick delivery, and the railroads have come to recognize that service to shippers must not only include fast transportation but must even cover notification to consignees of the progress of the shipments. Throughout the United States all live business houses have keyed up to fast transportation. Economic pressure dictates speed and ever more speed. To keep abreast of the times, shipowners must meet that demand. In shipping very truly the race is won by the swift and the strong. Strong foreign companies are outdistancing their competitors by increasing the speed. If we in this country will stay in the race we too must make better speed.

Shipowners of course must seek a profit. Service to shippers is not adequate in itself to make the profit, but must be linked with sufficiently economical operation to yield a satisfactory return on the capital invested. How are the higher speeds to be paid for? Extra speed obviously cannot be attained without extra expense. How will that expense be met? The faster vessel costs more to build: therefore, the fixed charges will be higher, i.e., the interest on the capital, the depreciation and the insurance will cost more. Some of the direct operating charges will be higher, because the more powerful machinery will burn more fuel, use more engine-room stores and cost more for maintenance. In what way are these higher costs recouped?

In the first place, it is an axiom of the transportation business—at sea, on land and in the air—that speed is entitled to its premium. Conference rates invariably discriminate between fast vessels and slow vessels when there is an appreciable spread between the speeds. Generally this is emphasized by the demand of the slow vessels for the right to quote lower rates, an example of which—confessing the true inferiority of governmental tonnage—is the fight the Shipping Board is waging on behalf of its American Diamond Line against the North Atlantic-Antwerp-Rotterdam Conference—in other words, the Shipping Board is insisting that the inferiority of its vessels be endorsed by the Conference. Yet,

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though in most conferences the squawking is done by owners of slow boats, the level of the rates is generally determined by the owners of the fast boats. On routes where there are no conference rules the amount of tonnage in the trade influences the rates, but always the advantage rests with the fast vessels, particularly when the extra speed is combined with frequent sailings.

In the second place, apart from the purely economic factors influencing rates on any specific route the higher speed vessel makes more voyages per year and correspondingly increases its gross revenue. If we assume that a 10-knot vessel is at sea 200 days in the year and the rest of the time in port, an increase of her speed to 12 knots will augment her gross earning capacity about 10 per cent, even though on the basis of the same relative port time, she will spend 15 days more in port during the year. An increase of speed to 14 knots will make her gross earning capacity about 16 per cent greater even with 25 port days extra per year. At 16 knots she will have about 21 per cent greater earning capacity, with 33 port days more per annum. For approximation these figures will pass, but for precise calculation they would have to be adjusted for two partly compensating factors, one being reduced earnings on account of smaller cargo space due to heavier machinery and bunkers and the other being reduced port time by reason of the smaller cargo to be handled, this in turn leading to still further increase of time at sea. The fact that the gross earning capacity is considerably augmented by the speed is, however, clearly indicated by the examples quoted.

Increased revenue can come only from these two sources, unless passenger traffic be sought with the increase of speed or unless the port time be reduced. Of all ways to expand earnings the latter is potentially one of the most profitable. Its possibilities can be grasped from the plain statement that if the port time of the 10-knot vessel mentioned above be cut from 160 days to 100 days for voyages totaling 200 days, that change alone would be equivalent to an addition of about 20 per cent to the gross earning capacity. Such a change of course would not help the vessel to meet the competition of the ever increasing speed of freighters, but it enables one to visualize how improved operation can be of great assistance in meeting the higher fixed charges of increased speed at sea. It is of course true that the greater the investment in a vessel the greater the urge to strive for quicker dispatch, and in practice the modern fast motorships are being turned round more quickly in order to increase earnings.

To what extent the greater fixed charges of the fast freighter contribute to the swelling of operating expenses depends on the cost of the vessel and on the cost of the capital. If shipbuilding costs in this country are assumed to be 50 per cent higher than in Europe, then the loan provisions of the Merchant Marine Act 1928 may be accepted as equalizing the capital cost here and abroad, but leaving the American shipowner with the handicap of depreciation and insurance on the 50 per cent higher portion of the cost. Payroll, food, fuel, stores, maintenance, etc., being obviously about the same on American ships as on the foreign ships that operate out of American ports without touching at a home port—and these latter are the ships with which the American shipowner is directly in competition—the net handicap under the American flag would be the depreciation and insurance of the premised 50 per cent higher portion of the capital cost unless this too were counterbalanced.

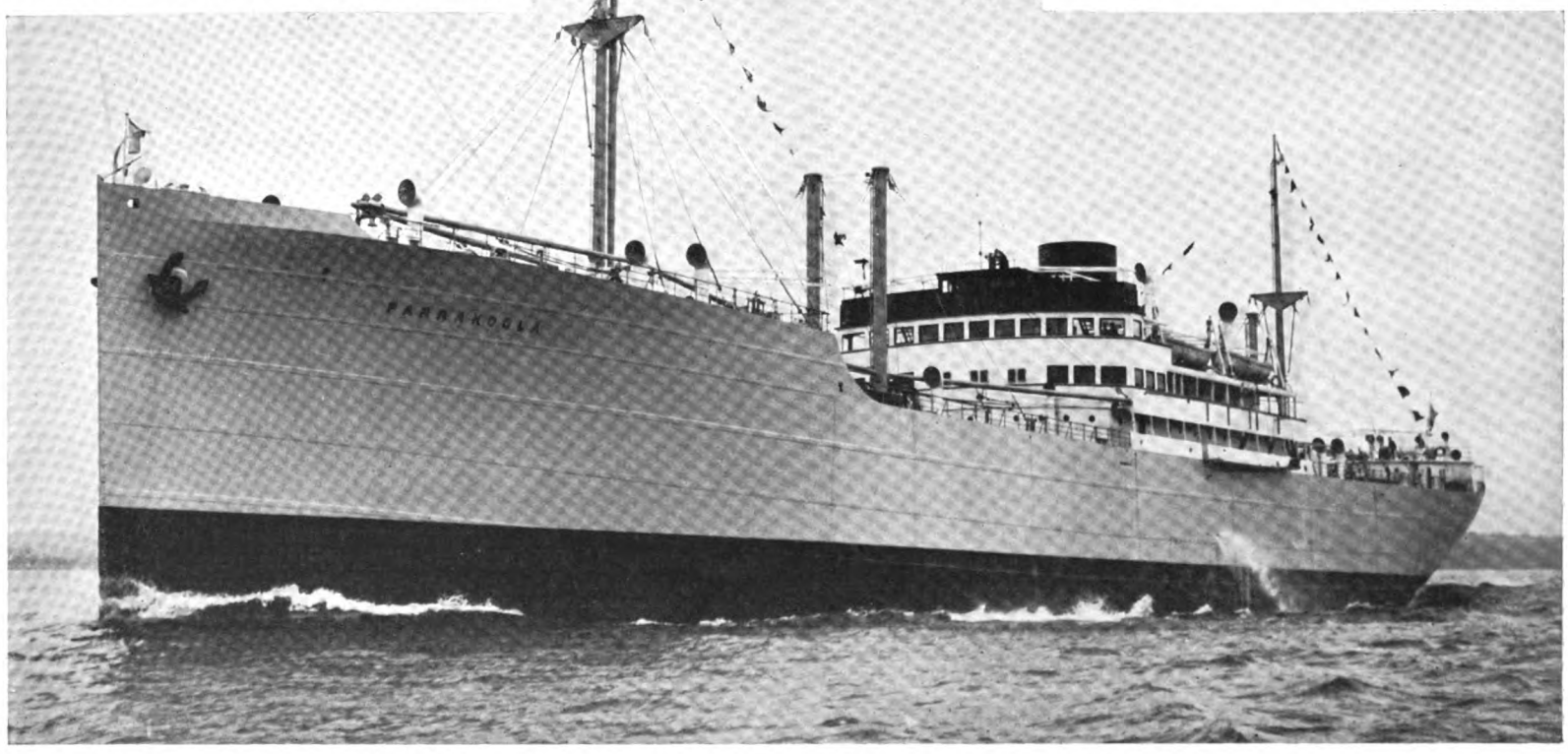
Indications are that this handicap will certainly be offset for 10 years by the generous mail contracts which the Post Office is making under the terms of the Merchant Marine Act 1928. (Until the mail lines begin buying new tonnage these Post Office contracts, in nearly every case, are nothing less than velvety subsidies, due to the fact that the old tonnage of most of these lines was sold by the Shipping Board at prices that reduced the fixed charges to a much lower level than the foreign lines enjoy).

Thus it may be taken that American companies securing mail contracts are on the same basis as foreign companies in American overseas trade, because, the financial factors being equalized by national agencies and the direct operating expenses being on the same level, the economic differential heretofore existing is wiped out. There remains no ground for arguing that the American companies will suffer any economic hindrance in meeting the higher speeds now being established by foreign lines.

It behooves the Shipping Board to enforce upon the mail lines the highest standards prevailing in the modern shipping practices of the world's leading companies. Use of public money entrains a public duty. Shipowners seeking the privilege of borrowing money from national funds and soliciting the aid of mail subsidies must be prepared to recognize that the public in return for that assistance requires its welfare to be served. The man who pays the piper calls the tune.

A nation that is ready to lend a quarter of a billion dollars for ship construction and is willing to enter into 10-year contracts for the payment of huge mail subsidies—one hundred million dollars having already been signed over to shipowners by the Post Office—that nation is not going to be content with tonnage of any old fashioned sort. Public money is a temptation to greed and dishonesty, and honest shipowners will welcome measures designed to check perverted use of the Loan Fund established by the people to assist the upbuilding of a first class merchant marine.

(*Continued at foot of page* 1001)



Designed for loaded sea-speed of 15 *knots in round-the-world service of Transpacific Co.*

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Diesel Engine Operated Four Years on Powdered Coal

By H. Schreck

AT the present time fuel oil may be considered the leader of fuels for the production of power, particularly in the marine line. The price of fuel oil is at a very low level; unfortunately, there is still quite a differential between it and the price of Diesel oil. In regard to the future fuel supply it is easily realized that the prices of fuel oil and Diesel oil will rise again, and it is known that the amount of oil producible is only a fraction of that of coal, lignite, peat, etc.

MOTORSHIP recently referred to a new engine, using powdered coal as fuel and thereby taking advantage of a low price fuel and of the high thermal efficiency of the Diesel engine, worked out in Germany by Mr. Pawlikowski, its inventor and manufacturer. One of these converted engines is installed in his plant in Goerlitz and has been driving the machine shop for four years of continuous operation. The cylinder bore and stroke of this vertical 4-cycle engine is about 16½" x 25". It may be run either on fuel oil or powdered coal, and may be switched from one to the other fuel while in operation.

This particular engine, originally an M. A. N. Diesel engine, was converted for this purpose by installing a new cylinder head and another fuel cam. A new cylinder head is required in order to provide for the new fuel valve. The latter contains the fuel measuring device, controlled by the governor, and also a chamber for holding the powdered coal required for each power stroke, which is subsequently released into the cylinder by a second valve. Both valves, one for admitting the proper amount of powdered coal, according to the respective load of the engine, which is done under atmospheric pressure, and the other valve for admitting the fuel to the cylinder, are operated by one cam. One valve works inside the other, that is, the latter is in the form of a sleeve sliding up and down on the inner valve.

During a visit of the writer at the plant in Goerlitz, early in 1927, two demonstrations were carried on in order to show that the proportioning and combustion of powdered coal for each stroke is just as uniform as it is with fuel oil. The first test was made by taking 25 indicator cards without removing the writing pin from the indicator drum, and the cards registered exactly as though one card had been taken. The second test was made by tipping down the governor lever with the load on the engine, that is, bringing the engine out of balance, and the governor swung back to a stable condition almost instantly, picking up the load remarkably.

At the time of this visit the fuel used was brown coal with a content of 10% ash and 12% moisture, supplied to the engine through a vertical pipe, which at its lower end was attached to the fuel valve in the cylinder head, and at its upper end was screwed to the bottom of a barrel standing on the floor above, containing the brown coal in powdered form. A great variety of fuels, from anthracite to the cheapest grade of fuel have been tried out in this engine with equal success.

The question is sometimes raised as to how the ash content of the coal affects the operation of the engine and the wear of the cylinder. Since only actual experience can answer this question, it may be quoted that the engine mentioned above was bought as a used Diesel engine, it has seen the hard service of an experimental engine. It is driving the factory every day of the week, and has been doing so for four years, and yet the original liner is still in service, without having been rebored.

FACING the alternatives of wastefully burning cheap coal under boilers or more economically burning comparatively expensive fuel oil in Diesels, German engineers seek a way out. One obvious step was to combine the use of the cheapest kind of fuel with the most efficient type of prime mover now being used for the conversion of the heat of combustion to useful work. Hence the coal-burning Diesel, which was the original thought of the late Dr. Rudolf Diesel. Urging German engineers are two very important beliefs, one of which is true and the other problematical, namely, that the price of fuel oil will advance, and that the world's supply of fuel-oil will eventually become exhausted. In any event the coal-burning Diesel may, through necessity, become the answer to several very important German economic problems, if not of the world.

If an engine is operated on powdered coal, the cost of fuel is reduced to about one-third of that of fuel oil, on the basis of 5 cts. per gallon for fuel oil delivered, and $3. per ton for coal delivered, adding 75 cts. per ton for pulverizing. The latter figure will be much lower in most cases.

The most efficient steam plants with their giant steam turbines, high pressure and superheated steam, produce power at the consumption of one lb. of coal per kw hour. This is a record figure obtained in less than half a dozen plants during tests and which, of course, cannot be maintained in every-day-operation over any length of time. Units of the size and similar load conditions as the Diesel engine has to deal with, have a coal consumption of between 1.8 and 3 lb. per b. hp. hr. on steamers, and in stationary plants with steam engines, records over periods of months show a coal consumption of between 3 and 6 lb. per kw hour. In every case, coal consumption is given as required for all purposes, including auxiliaries. On the Diesel engine it is somewhat less than 1 lb. per kw. hour. This means that the owner of a small plant, the small or medium size central power plant, and the owner of smaller vessels may produce power with the same cheap fuel as the most up-to-date giant power plant or steamer and at a considerably lower price.

While this converted engine served to supply the power for the factory, four more engines of different types, horizontal and vertical, were on the test stand for the purpose of experimentation and testing out various makes of oil engines for powdered coal. At the time of the writer's visit, there were also two 3-cylinder Diesel engines in the factory, supplied by two leading European manufacturers, which were to be rebuilt for powdered coal to their order. These engines are probably converted and tested by this time.

These two orders for modification of Diesel engines by leading Diesel engine manufacturers is very significant and proves the interest taken by Diesel engine builders in this work. The importance is easily understood because this modified engine will not only cut the cost of operation of Diesel engines in certain districts, but will offer a far broader field of application to the Diesel engine. It may then successfully invade the coal districts.

Motorships With Reduction Gear Drive

THE number of motorships driven by Diesel engines through reduction gears is steadily increasing. It will be seen from the following list that while a considerable amount of Diesel reduction gear development work has been carried out in the United States, the majority of installations have been completed in Germany and operating results indicate satisfactory service obtained. They are as follow:

Ship's Name	S.hp.	Type of Engine	Owner
LIBBY MAINE	500	Dow Diesel	Libby, McNeil & Libby
HERMAN FALK	1,200	Falk	Oil Transport Line
FRIESLAND	7,200	Vulcan-M.A.N.	Hamburg America Line
DUISBURG	4,000	M.A.N.	Hamburg America Line
RENDSBURG	4,000	M.A.N.	Hamburg America Line
HAVELLAND	3,300	M.A.N.	Hamburg America Line
MUNSTERLAND	3,300	M.A.N.	Hamburg America Line
MONTE SARMIENTO	7,000	M.A.N.	Hamburg-South America Line
MONTE OLIVIA	7,000	M.A.N.	Hamburg-South America Line
ST. LOUIS	12,400	M.A.N.	Hamburg America Line
MILWAUKEE	12,400	M.A.N.	Hamburg America Line
DREDGE	900	Falk	Hill Dredging Co.
DREDGE	900	Falk	Hill Dredging Co.
Not Yet Installed	2,200	Falk	Falk Corporation

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New Diesel Ferry at Fort Jay

Saving in Fuel and Reduction of Crew Amounts to $66.00 per Day

A NEW addition to the ever-increasing fleet of Diesel powered craft on New York harbor is the ferryboat GENERAL CHARLES E. HUMPHREYS, recently delivered to the Quartermasters Corps, War Department at Governors Island, New York. She is of steel construction, built by the Spear Engineering Corp., Norfolk, Va., and powered with a 400 hp. Fairbanks, Morse Diesel.

The engine, located amidship, is connected through clutches to propellers, one at each end of the boat. Manoeuvering is facilitated by the employment of direct mechanical pilot house control of the engine. All auxiliary machinery in the engine room and the steering gear are electrically operated with power supplied by a Fairbanks, Morse 30 kw. Diesel generating set.

The saving in cost of operation as compared to that of the steam ferryboat formerly in this service is of startling magnitude. The cost of fuel for the Diesel ferryboat is estimated at $6.70 per 24 hour day whereas that of the GENERAL OTIS was $67.00 per day according to figures on the last quarter's operation. An additional saving of $6.00 per day will be effected because the Diesel ferryboat operates with three less men in the engine room.

Chief Characteristics

Length over guards	128 ft.
Length on waterline	118 ft.
Breadth over guards	44 ft.
Extreme depth of hull	15 ft. 2 in.
Draft	8 ft. 6 in.

To afford ease of construction at reduced cost the hull was designed on as straight lined cross sections as possible and so the frames are practically straight with an easy turn at the bilge. A deck house with steel sides encloses the main deck space and covers the main portion of the vessels. Two gangways for the accommodation of vehicles occupy the center space of the main deck. During inclement weather these gangways may be closed by two double-swinging steel doors, if desired. Grooved steel pavement is used as decking for the driveways and open ends of the vessel while the side cabins are decked with concrete laid in small squares.

A men's cabin occupies one side of the amidship cabin and a women's cabin occupies the other. A saloon and pilot houses are located on the upper deck with a portion of the saloon arranged as an officer's cabin with toilets adjoining. Inlaid linoleum covers the floors of this cabin and the walls are finished in white.

Settees outside of the cabin on the upper deck are provided for the ones who care to ride in the open air. These extend the length of the cabin between the two pilot houses, one of which is located at each end of the boat.

In addition to the main and auxiliary Diesels previously mentioned auxiliary equipment includes the following—with electric motors supplied by the General Electric Company:

1 Fuel pump. Centrifugal type 4 in. 350 g.p.m. Fairbanks-Morse with 40 hp. motor drive.

1 Fire pump. Horizontal duplex type, 5¾ x 6 in., 100 g.p.m., Fairbanks- Morse, with 7½ hp. motor.

1 Sanitary pump. Centrifugal type, 2 in. 100 g.p.m., Fairbanks-Morse, with 5 hp. motor.

1 Fresh water pump. Centrifugal type 1½ in. 40 g.p.m. Fairbanks-Morse, with 2 hp. motor and Cutler Hammer pressure regulator.

1 Circulating pump. Horizontal simplex 5 x 6 in. 100 g.p.m. Worthington with 5 hp. motor.

1 Fuel oil transfer pump. Rotary type 20 g.p.m. Worthington with a 2 hp. motor.

1 Auxiliary air compressor. Worthington 2 stage, 52 cu. ft. of free air per minute with 20 hp. motor.

1 Almy watertube heating boiler with 335 sq. ft. heating surface and Aetna automatic oil burner.

2 Electric steering gears. American Engineering Co. drum-type, controlled by a Cutler Hammer non-magnetic helm angle indicator located in pilot houses.

In addition to the equipment mentioned the ferry has been fitted with ample fuel, oil and fresh water tanks, storage locker rooms and crews locker, all below the main deck. The hull is divided into five main compartments by means of four watertight transverse bulkheads. Substantial construction resulting from proper execution of carefully worked out plans characterize this craft as an excellent example of the shipbuilding art.

The excellent design of this ferryboat was prepared by Frank Van Vleck, supervising marine engineer at the office of the Quartermaster General, Washington, D. C.

His careful attention to every important factor entering into this vessel's construction is evidenced by the use of fireproof decking in the driveways. This seems to be an entirely new thought that is of special significance because of the almost complete replacement of horse drawn vehicles by autos and the increased fire hazard.

Atlas-Imperial Diesel Company's New Address

Formerly located at 165 Broadway, New York City, the Atlas-Imperial Diesel Engine Company's Eastern Division offices are now located at 115 Broad Street, New York, N. Y. The Eastern Division recently has sold a number of engines for installation in fishing vessels on the Atlantic Coast.

World Standard of Fast Freighters Moves Up

(*Continued from page* 999)

As trustees for the people the Shipping Board must make as close scrutiny of the applications for loans as a bank would make in similar circumstances and must exercise just as keen business intelligence in sizing up the management and the business prospects. For, in addition to the ability of the lending company to pay the interest and repay the loan in full there must be a value given to the nation as return for its acceptance of the bank risk at far below the banks' rate.

This value can only be given by contribution to the improvement of the merchant marine. When, additionally, a mail subsidy is held by a company utilizing the loan aid of the Merchant Marine Act, 1928, the nation will look to the borrower for still greater value as return for the assistance given to him. Why else should the nation lend money for shipping or write contracts for the carriage of mails at rates for higher than the minima obtainable? This aid to shipowners is solely for the purpose of benefiting the nation.

In every loan made by the Shipping Board there must be clear value given by the borrower to the nation. The Merchant Marine Act was not passed to let grabs be made for money. It was passed to build up a worthy merchant marine ranking in quality with the best in the world. On this the Shipping Board must insist, for it will be held to strict accountability by a party system that is ever watchful for opportunity to denounce negligence in the use of public funds, and which will not overlook the potentialities for denunciation where such enormous sums of money are concerned as Congress has provided to secure the benefit of a modern and efficient merchant marine for the nation.

The tremendous development of the motorship by foreign companies, the building abroad of 15-knot and 16-knot freighters, the improvement shown in combination passenger and freight liners through the adoption of Diesel power and the almost universal acceptance, outside this country, of the motorliner have set new standards, far beyond the old ones that still prevail here. Seventy years of decline have left their mark on American Shipping circles, creating a habit of mind that lives in the past instead of in the future. This torpor must be shaken off before public money is loaned. Were it to be tolerated, the nation would have no more to show for its financial assistance to shipping companies than a second fleet of out-of-date vessels.

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Interesting News and Notes From Everywhere

THE stern-wheel Diesel towboat CATHERINE D, built at the Nashville Bridge Company's plant, Nashville, Tennessee, has just gone into regular charter service on the western rivers.

A Diesel tug 55 ft. in length and 12 ft. beam has been delivered to the United States Quarantine Service at Boston and replaces the tug WASDIN, which has been taken to Philadelphia.

Puget Sound Navigation Company are having tentative plans drawn for a new passenger automobile ferry, in which the type of motive power has not definitely been settled. It may be Diesel-electric.

The Diesel electric dipper dredge ordered by the Great Lakes Dredge & Dock Company from the Bucyrus Company is being constructed under sub-contract at the Manitowoc Shipbuilding Corporation, Manitowoc, Wis.

The Diesel yacht HI-ESMARO, now under construction at the Bath Iron Works, will be 267 ft. in length and powered with two 1,500 b.hp. Bessemer Diesels. They are calculated to give her a speed of 15 knots.

Although the plant and general offices of De La Vergne Machine Company, have moved from New York to Philadelphia, the firm still maintains a large staff at their New York branch offices, 100 Broadway, New York City.

A new Diesel tug 65 ft. overall in length was recently completed for the U. S. Engineer Office, Galveston, by the Charles Ward Engineering Works, Charleston, West Virginia. A complete description of this tug is scheduled to appear in an early issue of MOTORSHIP.

The successful bidder for the construction of the Manhattan State Hospital Diesel ferryboat is the New London Ship & Engine Company, Groton, Connecticut. The engines for this ferry will be supplied by the Winton Engine Company, of Cleveland, Ohio.

Another regular service from the Pacific Coast to the United Kingdom starts with the sailing this month of the new motorship EAST LYNNE, a sister ship to the WEST LYNNE. Both ships are new vessels of 9000 tons dw.c. This service is being inaugurated by the Reardon Smith Line of Cardiff, Wales.

A complete list of all tankers in service to date with all of the principal characteristics as to size, carrying capacity power, type of machinery and speed, as well as the name of the builders, owners and operators, has been compiled by the Standard Navigation Company of 25 Broadway, New York, and bound in an attractive leather back volume. It is perhaps the most complete available compilation of information concerning tankers and should prove to be of inestimable value to anyone requiring such information.

The Falk Corporation, Milwaukee, recently published their new Bulletin No. 180 on Falk Flexible Couplings. This bulletin contains information not included in the issue it supersedes and it lists one additional size of coupling—the 20½ C. It also contains a new list of service factors which have been reduced to allow for the selection, in most cases, of smaller and hence less expensive couplings.

It describes the CS type developed particularly for close coupled applications and also the CH type added to the standard line for high speed turbine work. Both these types retain the same operating principle as the standard series which has been on the market for some years and are particularly adapted for absorbing shocks and compensating for misalignment of coupled shafts.

The 106 ft. yacht building at the plant of the Consolidated Shipbuilding Company, Morris Heights, New York, for L. M. Wainwright will be powered with two of the new 300 b.hp. Speedway Diesels described on page 842 October MOTORSHIP.

Trawler Boston College described on page 925, Nov. MOTORSHIP

Two additional "Silver" ships will be equipped with refrigeration facilities to add to existing space provided by the Kerr Line service from San Francisco to Yokohama, Kobe, Shanghai, Manila, Java and Singapore, according to announcement made recently at the offices of the General Steamship Corporation. The vessels to be so equipped are the SILVERASH and the SILVERBEECH, and they will each have available 40,000 cu. ft., sufficient to lift approximately 800 measurement tons of perishable cargoes. The Kerr Steamship Company has just contracted for the construction of three motorships of 9000 tons dw.c., each to be built by a shipyard at Newcastle-on-Tyne, according to a recent report. The new vessels will make a total of 15 "Silver" vessels in operation out of New York and Pacific coast ports.

The New York office of the Atlas Imperial Diesel Engine Company reports a number of interesting recent installations of their engines as follows:—one 200 hp. in the fishing schooner RUTH and MARGARET, owned by Capt. Valentine O'Neil, Gloucester, Mass.; one 200 hp. main propulsion unit and a 70 hp. auxiliary unit for winch operation in the fishing schooner GEORGINA M, owned by the Coast Fisheries Company, Boston, Mass.; one 110 hp. in the fishing schooner ROMONA, owned by Powers & McDonald, Gloucester, Mass.; one 140 hp. in the fishing schooner JACKIE B, owned by Capt. John F. Barrett, Gloucester, Mass.; one 70 hp. in the power boat MISS DAUGHERTY, owned by Capt. Nonie Holland, Crisfield, Md., and one 200 hp. in the tugboat VISITOR, owned by the Inter-State Oil Transport Company, of Philadelphia.

Installation of Atlas Imperial Diesels in four other boats, and also on schedule, include:—one 275 hp. main propulsion unit and a 70 hp. for winch operation in a fishing schooner, not yet named for Capt. Harry C. Ross, of Gloucester, Mass.; one 70 hp. in the power boat for Capt. A. G. Price, of Princess Anne, Md.; one 45 hp. in a power boat for Wm. A. Steward, Crisfield, Md., and one 140 hp. to be installed in the ferry boat OCEAN BEACH owned by Capt. A. Robinson, Bayshore, L. I., N. Y.

What promises to be a very successful move, a Diesel engine, has been installed in a boat at Vancouver, B. C. It is a product of the Cameron Diesel Engine Company of that city. Certain minor adjustments are being made on the engine prior to releasing a description of it. It is of the 2-cycle type and employs base compression for scavenging purposes. An unusual feature, but one that is said to be receiving considerable attention by European manufacturers is an unlubricated roller bearing in the top end of the connecting rod, and is being experimented with on this engine.

The consolidation of Symons Brothers Company with the Nordberg Manufacturing Company is of particular interest to those industries where crushing processes are involved. This brings together one of the leaders in the crusher field with a company long prominent in the design and building of large and highly efficient machinery particularly well known in the mining field. With the Symons Brothers Co. becoming a part of the Nordberg Manufacturing Company a continuance of past policies is assured. The same representatives engaged in the sale and servicing of Symons Crushers will continue to do so in the future. The Crusher Department will be transferred to the Main Office of the Nordberg Manufacturing Company at Milwaukee; branch offices will remain at New York and Los Angeles.

Contracts Let for Five Diesel Yachts

Three luxurious Diesel yachts, each costing $1,000,000 have been designed for Alfred E. Sloan, Jr., president of General Motors, Fred J. Fisher, official of the same organization, and another automobile executive, whose name was not released in the announcement made recently by John H. Wells, New York naval architect, who designed the yachts in association with Cox & Stevens. All will be delivered by next summer.

Two additional orders calling for construction of a $500,000 yacht for Charles F. Ketterling, chief engineer of General Motors and a $200,000 yacht for Jules S. Bache, New York financier, were placed at the same time. The orders totaling $3,700,000 are said to represent the greatest sum ever placed with an American designer of yachts.

The $1,000,000 yachts, which will be built by Pusey & Jones, of Wilmington, are identical in every detail. Designed as clipper stem vessels, they have an overhang of 40 ft. giving a water line of 196 ft. They will have an overall length of 236 ft., 34 ft. beam and a draft of 14 ft. These three yachts will be driven by two 6 cyl. airless injection Winton Diesels of 1,100 b.hp. each giving a speed in excess of 15 knots.

The yacht to be designed for Mr. Ketterling will be built at the Defoe Boat and Engine Works, Bay City, Mich. This craft will be 170 ft. long with a 26 ft. beam, and will be driven by two 500 b.hp. Winton Diesels at a speed of 14 knots.

Mr. Bache's vessel will be built at Jacob's Shipyard, City Island, N. Y. She will be 112 ft. long with a 19 ft. beam. Two Winton Diesels of 350 b.hp. each will give her an estimated speed of 18 knots.

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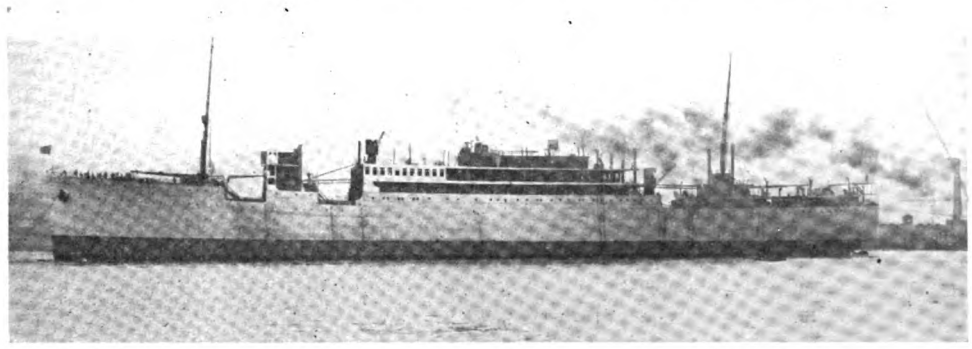
M.A.N. Diesels of 3,000 b.hp. will be installed in the German built Standard Oil tanker now under construction at the Vulkan Yard, Hamburg.

Orders for four single-screw motorships, each of about 4000 tons gross, have been placed by Elder Dempster Company, Liverpool.

Two Fiat Diesels of 3,000 b.hp. at 150 r.p.m. are installed in the FILIPPO GRIMANI, which ran trials recently in charge of her builders, the Stabilimento Tecnico Triestino, of Italy.

ASA MARU, the first of six Diesel N. Y. K. motor-liners for transpacific service, was launched at the end of October at the Mitsubishi dockyard, Nagasaki, Japan. Three of them, including the ASA MARU, are of 31,800 tons displacement each.

The most powerful Diesel tug in Canada is the GEORGE M. MCKEE, owned by the Anti-



Highland Chieftan, third of five sister motorships for service between Great Britain and South America

costa Corporation, and recently placed in service towing logs at the Island of Anticosta. She is powered with a 5-cyl. Fairbanks-Morse Diesel that delivers 700 b.hp. at 250 r.p.m. She is 107 ft. in length, 26 ft. beam and 12 ft. moulded depth. With a speed light of 14 knots but little time is lost between tows.

The first tanker constructed in the Netherlands on the Isherwood bracketless system is a Diesel ship of 10,950 tons dw.c. to be powered with two six-cylinder single-acting Werkspoor engines calculated to give a speed of 11½ knots.

Launched recently at the Triest, Italy, shipyards were the motorships PIERO FOSCARI and FILIPPO GRIMANI, each of 1,350 gross tons, for the San Marco Company of Venice, and the VERDI of 2,900 gross tons for the Adria Company of Fiume.

Trunk piston Diesel engines aggregating 4000 s.hp. will be installed in each of two refrigerated-cargo motorships ordered from Armstrong Whitworths by Westfal-Larsen Co. They are of Kincaid-Harland-B. & W. four-cycle type.

Franci Tosi are developing a 2-cycle single-acting Diesel to be installed in the 5,400 gross ton motorships now under construction for service between Naples and Palermo. Each ship will have two 6-cylinder engines capable of developing 4,000 b.hp.

Two twin-screw motorships have been ordered by Alfred Holt Company. One of these will be built by the Scotts' Shipbuilding & Engineering Company, Greenock; the other by the Caledon Shipbuilding & Engineering Company, Dundee. The Dundee vessel will have Diesels of the North Eastern Marine type and will be fitted with Buchi's exhaust turbo charging equipment. No official information has been released regarding the machinery of the Greenock vessel.

A second 13½-knot motorship has been ordered by the Compagnie Generale Transatlantique to be powered with two 3,000 i.hp. M.A.N. double-acting Diesels.

The first of the two 16-knot 16,000-ton Diesel reduction gear drive vessels MILWAUKEE and ST. LOUIS, building for the Hamburg-Amerika Line, was successfully launched last month. Both vessels will probably be completed in 1929 and placed in service between Hamburg and New York.

HIGHLAND BRIGADE, launched November 1, is the third of five twin-screw passenger and refrigerated cargo motorships building for H. H. Nelson, Ltd., by Harland & Wolff, Ltd., Belfast. She is a sister ship to two vessels already launched. One of these, the HIGHLAND MONARCH, described on page 935 November MOTORSHIP, is now on her maiden voyage. These are vessels of 14,137 tons gross and are powered with twin Harland-B. & W. six-cylinder double-acting Diesels of 5,000 b.hp. each.

New vessels for the French Navy include the motor-tanker LE MEKONG, launched at the Penhoet yard of the Chantier et Ateliers de Saint-Nazaire-Penhoet. She is 460 ft. long overall, 62 ft. broad and 34 ft. deep, and will have a deadweight capacity of 9700 tons, the corresponding draught being 26½ ft. The propelling machinery will be two Burmeister & Wain four-cycle single-acting six-cylinder Diesels of 6600 i.hp. at 125 r.p.m., giving a service speed of 13.5 knots. A sister ship, LE NIGER, also ordered by the French Navy in 1927, is building at the Bordeaux yards of the Ateliers et Chantiers Maritimes du Sud-Ouest, the Burmeister & Wain machinery being constructed by Schneider et Cie.

The twin-screw motorship CALGAROLITE, built by the Furness Shipbuilding Company, Ltd., of Haverton Hill-on-Tees, for Imperial Oils, Ltd., of Toronto, a vessel of two deck type, with cruiser stern, large after deckhouse, bridge and forecastle. The hull, built on the Isherwood "bracketless" system of longitudinal framing, meets Lloyd's highest class for the carriage of oil in bulk, and the British and Canadian Government requirements. Following are the principal dimensions: length, 542 ft.; breadth, 70 ft. 6 in.; depth, 38 ft. 9 in. to upper deck; a deadweight of approaching 16,000 tons being carried on a draft of about 28 ft. 6 in.

The main propelling machinery is being supplied by Fried Krupp, of Keil, and will be installed by the builders. It consists of two two-cycle single-acting reversible air injection Diesel of six-cylinders each, 38.98 in. bore by 51.18 in. stroke each, developing 6000 i.hp. and capable of propelling the vessel at 12 knots.

Two 13,000 dw.c. tankers were ordered recently by the United Molasses Company—one from Wm. Hamilton & Co., Ltd., and the other from R. Duncan & Co., Port Glasgow. Two B. & W. Diesels, with a total power of 3,800 i.hp. at 110 r.p.m., are to be installed in each ship, and are calculated to give a speed of 11 knots.

The Rotterdam Lloyd has ordered a sixth motorship similar to the 9,500-ton 15-knot cargo ship recently ordered from the de Schelde yard for the Dutch East India service. This vessel will be 467 ft. in length, 6 ft. 6 in. beam, 33 ft. 6 in. in depth, and will be powered with a Fijenoord M.A.N. Diesel of 5,200 b.hp. The propeller speed will be 86 r.p.m.

Soviet Russia has recently completed the first of a fleet of Diesel motorships—the ALEXEY RYKOV, a vessel carrying 300 passengers and 2,400 net tons of refrigerated and live-stock cargo on a deadweight capacity of 3,600 tons at 12 knots. The Sovtorgot, or State Mercantile Company plans to build a total of 176 vessels.

KARAMEA, last of the four 9,300-ton gross motorships recently built for the Shaw, Savill & Albion Line, has been completed by the Fairfield Shipbuilding & Engineering Company. This vessel is 481 ft. in length, 64 ft. beam and 30 ft. in depth. She will have a gross tonnage of 9,300 tons, and be powered with two Fairfield Sulzer Diesels of 7,450 b.hp. aggregate giving a speed of 15 knots.

Keel blocks for a 17-knot Diesel revenue cruiser, ordered by the Canadian Government for its customs and excise preventive service on the Atlantic coast, have just been placed in position at the Canadian Vickers shipyards, Montreal, and the keel plates were laid down on November 5th. It is expected that the ship will be finished next May. The principal dimensions of this craft are: Length 170 ft., beam 21 ft., and depth 13 ft. She will have a straight stem and cruiser stern, while ten water-tight and oil-tight bulkheads are being installed. The main fuel oil bunkers to be placed abreast the machinery will have a capacity for 60 tons of fuel.

The cruiser will be triple screw and propelled by three Winton Diesels, each of 600 b.hp. and driving four-bladed propellers at 450 r.p.m. As the ship may be used frequently in service at cruising speed only, this arrangement is expected to prove very economical, as only the central engine need be used.

A revival of shipbuilding in Japan after a very serious depression has resulted from the recent activities in motorship construction. At the Mitsubishi and Yokohama dockyards there are seven motorships under construction. In the former yard two 16,500 ton vessels are building for the Nippon Yusen Kaisha and two of 9500 gross tons for the Osaka Shoshen Kaisha, South American service. In addition they are building one 9000 ton motor-cargo vessel and two 10,000 ton motor-tankers. At the Yokohama dockyard the Nippon Shoshen Kaisha is having its third 16,500 ton motor-passenger liner built for service to San Francisco. They are also building two cargo-vessels of 15 knots service speed for their Seattle trade. The Osaka Shoshen Kaisha has also contracted for three 5300 ton passenger and cargo motorships to be built at the Yokohama dockyard where another 10,000 ton motorship is under construction. In all but about four of these vessels Sulzer Diesels constructed in Japan under Japanese license will be installed. In the other ships double-acting 4-cycle B. & W. type Diesels constructed in Europe will be installed.

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Second Warrior River tug for one of the U. S. Steel Corp. subsidiaries.

Diesel Electric River Tug

THE hull of the second Diesel electric tug for the Tennessee Coal, Iron and Railway Company is nearing completion at the Ambridge, Pa., plant of the American Bridge Company. Installation of the machinery will be carried out by the Carnegie Steel Company, Pittsburgh, Pa. As a duplicate of the first boat described in the July, 1928 issue of MOTORSHIP, this one will be 140 ft. long, 25 ft. beam and 9 ft. 3 in. in depth.

The machinery was ordered closely following the delivery of the first boat. It will consist of two 550 b.hp. Nelseco Diesels direct connected to two 335 kw., 250 volt General Electric Co. direct current generators operating at a speed of 250 r.p.m. The boat is of the twin screw tunnel stern type, and each propeller will be driven by a 400 s.hp. double armature motor turning at 140 revolutions per minute. The power for auxiliaries, lighting and excitation purposes will be furnished by two 40 kw. exciters driven off the main engines.

The Ward-Leonard system of variable voltage control will be used, and operating controls will be fitted both in the pilot house and in the engine room.

These modern towboats will operate between Birmingport, Ala., which is approximately fifteen miles from Birmingham, and Mobile. Due to the number of locks and the many sharp bends in the Warrior River, it was decided that a Diesel electric craft would offer great efficiency and flexibility for handling heavy tows.

The economy of the Diesel propelled boats as compared to steamers is self-evident even in the face of low coal prices, when one considers the speed of towing, continuous power output, the great reduction in the quantity of fuel necessary and the inherent economy of the Diesel engine as compared with steam propelled boats in similar service.

New Kind of Canvas

THE large ship operating companies are now using a fire and waterproof cloth resembling canvas in weight and said to be approximately 20 per cent stronger. The trade name of this material is Jaton cloth now being marketed by the Marine Canvas and Supply Co., Brooklyn, N. Y. The advantages of a material that is waterproof and fire resisting are many but when we add to them mildew, acid, oil and gasoline resisting qualities we have a material that is truly blessed with many sea going advantages.

The ordinary methods of waterproofing tarpaulins by the use of paraffin, asphalt or pine tar renders them temporarily waterproof and highly inflammable. Since all such substances are soluble in oil they are readily cut with gasoline or any other comparatively light oil and so they are easily removed from the canvas. Heretofore any substance used for the preservation and waterproofing of canvas has of necessity been a non-drying substance, or if not the canvas would break when folded. All such substances are subject to the action of heat and cold, some of them actually hardening in freezing weather until they would tend to break the fabric when folded, or so soft as to become smeary dirt collectors and distributors in tropical weather.

Jaton cloth is said to have none of these detrimental characteristics. It remains soft and pliable with a perfectly dry surface that will not soil clothing or hands that come in contact with it. It is, therefore, ideally suited to use as boat covers on passenger ships where passengers may come in contact with it or for open air swimming pools on deck.

Jaton "Alumilite" cloth is an aluminum-like metal surfaced material exceptionally attractive and well adapted to many uses not hitherto considered to be within the realm of canvas. The one characteristic of being non-inflammable makes it meet a popular demand for use on vessels emitting live sparks, or small fire-brands from the stack. The manufacturers of this material have made an important departure from the commonplace by producing a material that is not only different but a vast improvement upon what has heretofore been accepted as essentially right.

Trunk Piston Diesels in Big Ships

In many ways the new Australian coastwise motorship YANDRA would make a fine ship for Sound steamer owners of this country to study, as she demonstrates how such a craft can be built with her Diesel machinery occupying very little space, and having little weight as compared with steam power. The YANDRA has been built for the Adelaide Steamship Company, and has the following characteristics:

Cubic capacity, bales	52,000 ft.
Power	1,300 i.hp.
Trial speed	12 knots
Length, oa.	218 ft. 3 in.
Breadth, md.	35 ft. 0 in.
Depth	13 ft. 9 in.

Her main Diesel engine is a four-cycle, single-acting Burmeister & Wain trunk-piston unit turning at 125 r.p.m.

Another ship with trunk-piston, four-cycle Diesels is the CIUDAD DEL SALTO, just completed by Harland & Wolff for the Argentine Navigation Company. She has cabin and public room accommodation for 61 first and 48 third class passengers, as well as cargo holds forward, midships and aft, worked by electric winches and hydraulic cranes. She is propelled by twin six-cylinder Harland-B. & W. engines, giving her a speed of 12 knots.

Parrakoola in Service

Another splendid motorship recently completed at Gotaverken is the 9050 ton d.w.c. 15 knot PARRAKOOLA. She is a sister ship to the MIRRABOOKA which recently completed a notably fast and successful voyage around the world. Both of these vessels were built for the Transpacific Company, a new company associated with the Transatlantic Steam Ship Company, both under the management of Gunnar Carlsson.

Following the trial trip on which she made 16¼ knots, the PARRAKOOLA proceeded on her first voyage from Gothenburg to the Swedish port, Omea, to load a cargo of paper pulp for Australia.

Two 100 kw. and one 60 kw. Diesel generators supply power for the auxiliary machinery on the PARRAKOOLA all of which is electrically driven, as is the case on her sister ship the MIRRABOOKA. The former, however, has in addition to electrical auxiliary machinery an electrified galley.

Second Aorangi

An order for a slightly larger vessel than AORANGI will be placed shortly by the Union Steamship Company of New Zealand for its Canadian-Australasian Royal Mail Line between Vancouver, B. C., and the Antipodes. The new motorliner will measure 655 ft. length and 83.9 ft. beam, with a loaded displacement of 29,000 tons, and the interior fittings will be more luxurious than AORANGI'S. In four years' service the powerful Sulzer-engined transpacific motorliner has made a perfect record for regularity and quick turn-rounds, and her economy today is superior to her 1924 figures. When the new and larger motorliner is completed, the S. S. NIAGARA will probably be taken off the route.

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Men, Motors and Miscellany

By Resurgam

HENRY FORD believes in the United States and doesn't hide the American flag when he sends a ship to sea. Sure American brains can overcome difficulties of operation under American registry. "Providence helps those who help themselves," says he. Proved it all his life!

Proud of the Stars and Stripes on his globe-girdling motorship EAST INDIAN, which outpoints any ship of her size under any flag. Proud too of his new motorship LAKE ORMOC, supply ship for his rubber plantation in the Brazilian wilderness. May encounter opposition from coastwise navigation laws of Brazil, but is determined to fly the American flag so long as the laws of man permit.

Since she went on the berth last winter the luxurious 17-knot motorliner BERMUDA has made the round voyage from New York to Bermuda and back regularly every week. There is not a suspicion of vibration aboard, and not a sound in the passenger space from the 13,000 horsepower Diesel exhaust.

To pilot that big vessel of 20,000 gross tons in and out of Fort Hamilton harbor looks almost like tempting Fate, but so far Fate hasn't fallen for it. There are only two feet of water under her in the narrow, winding channel, and a moment's lapse in the perfect control of the Diesel engines would set her double bottom scrunching on the hard coral.

It makes the steam crowd madder'n hades to remind them that turbines never had a chance for this job because of their bum reversing.

When the Furness Withy people decided to operate such a large vessel in that difficult harbor they had their nerve, and no grander demonstration of the maneuvering excellence of the Diesel engine could ever be made than the big motorliner gives twice a week at Bermuda.

Coastwise shipping companies would have given their eyeteeth to be able to knock her. They had been solacing themselves with the ludicrous notion that she'd shake from stem to stern and bark like a submarine. A lot of questions are being asked of these officials and advisers who have been assuring their managements there is nothing to this Diesel business. Alibis are not holding up like they used to.

Maybe some of the Shipping Board technicians don't hate the sight of the BERMUDA. Her engines are of the type ruled out of the original Diesel conversion program as unreliable. There's a laugh—and a couple of ha-ha-s! He who laughs last, Captain G—!

But, I also got one for Sir Baronet of the Furness Withy Co.—excuse me if I haven't got the title right, and I forget exactly how to spell your name—why don't you buy a big Sperry stabilizer, or a couple of half-size ones if you're cramped for space, and install them in this BERMUDA liner of yours? It'd be a wow if you advertised "We guarantee you against O'Rourke. Money back if you're sick." You'd have all America going to the islands. That'd be a fast one to put over, wouldn't it?

Winton has always been a leader towards higher engine speeds. Their first engines were considered fast running at 350 r.p.m. 12 years ago, and when they jacked the speed up to 400, the wise ones shook their wise heads. When the 150 hp. engine was brought out for the Coast Guard and turned up to 450 r.p.m. the croakers threw fits.

Looks like Winton has something. Early this year a 200 hp. engine was introduced, turning up to 700 revolutions, and on the test floor I hear they have kept it buzzing at 1000. Since George Codrington took charge of the Cleveland plant he has kept the Winton outfit stepping right along.

Books I'd Like to Read

Fifteen Years' Experimenting, by J. B. Smith Wailailaie.
Round the World in 280 Days, by Capt. R. D. Stategood.
Rating of Diesel Engines, by Oh. Tis.
Million Dollar Sales, by Earl
How I Get That Way, by B. Sc.; A. M. Inst. N. A.; M. I. M. E., etc.
Antique Iron, by Bert Paulsen.
Government Aid to the Shipowner, by James Farrell.
J. H. C. and the Diesel Engine, by George Deepee.
The Wolf's Night, by P. A. S. Franklin.
Diesels with Steam Exhaust, by Chris K. Nudson.

The publisher who will bring out any, or all, of these books can have my order now.

The president of one of our shipping companies seems to have become convinced that we can't build Diesel engines in this country as good as they build them abroad. It's the bunk, but he believes it. They haven't a thing on us in quality of construction, and it is fair comment to state that only their newest shops can match our product. In development work they have the edge on us, because they can do it far cheaper than we can and they get better support from shipowners. To assert that we cannot build Diesel engines with the best of them is a lot of hooey.

An Open Letter

P. A. S. Franklin, President
Panama-Pacific Line, New York
Dear Mr. Franklin,

I heard you the first time. Thirty grand for Panama Canal tolls on your intercoastal liner CALIFORNIA looks like a bargain to me. seeing the Government built the canal. Suggest you route her one passage round the Horn and see how you make out.

Cordially yours,
RESURGAM.

Ten years ago the railroads suffered from hypochondria—you couldn't make them believe they weren't down and out. But they snapped out of it and made records. Shall be grateful to the American Steamship Owners' Association for examples of similar pep that its members have put into their business in the last 10 years.

Performance of the Converted Motor Vessels of the U. S. Shipping Board

A paper read by Captain R. D. Gatewood, (CC), U. S. Navy, at the thirty-sixth meeting of the Society of Naval Architects and Marine Engineers, held in New York on Nov. 15th is an unvarnished presentation of actual facts and figures based upon a performance that fully justifies the Board's action in converting the first twelve vessels. The paper reads in part:

"Each of the twelve vessels which were converted has sailed at least 13,000 miles and many of them have considerably greater mileage than this to their credit.

"The actual detentions at sea that may be charged to equipment installed at the time of Diesel conversion which have occurred on the twelve vessels during the twenty-six voyages that they have made up to the time this paper has been written, are tabulated. It is to be noted that for the 46,941 total sea hours, the total detentions amount to 408 hours, or less than one per cent. The detentions have been due to several reasons, such as steering engine trouble, silencer, contaminated fuel, piston rods and cooling systems, the majority of the detentions, as may be seen from the table, being due to cooling system troubles.

"It has been our observation, in studying the operating performance of the numerous vessels of the government fleet, that when a vessel is taken out of lay-up and put into commission it requires approximately fifteen months as a shake-down period before consistent economical performance is obtained. It is felt, however, that the results shown in this paper can be taken as a fair indicator as to what should be expected.

"With the exception of the first voyage of the MS. TAMPA and the MS. WEST HONAKER, the initial voyage of each of these vessels has been anywhere from approximately 13,000 up to 28,100 miles. The twenty-six voyages made by the vessels include three to Europe, four to the east coast of South America, eight to the Far East, and eleven around the world.

"It is to be noted that these vessels have been consistently kept in long distance trade routes, as it is in this particular service that the Diesel has demonstrated its greatest value by its ability to bunker sufficient oil for long journeys at such points where fuel can be secured at a low price and at the same time not interfere greatly with the cargo-carrying capacity of the vessel.

"It is in port service that the Diesel engine has an unquestionable advantage over the steam-driven cargo vessel, as stand-by losses are practically eliminated. It will be noted that the Daily Port Consumption varies from the maximum of 7.1 to a minimum of 3.96 barrels per day."

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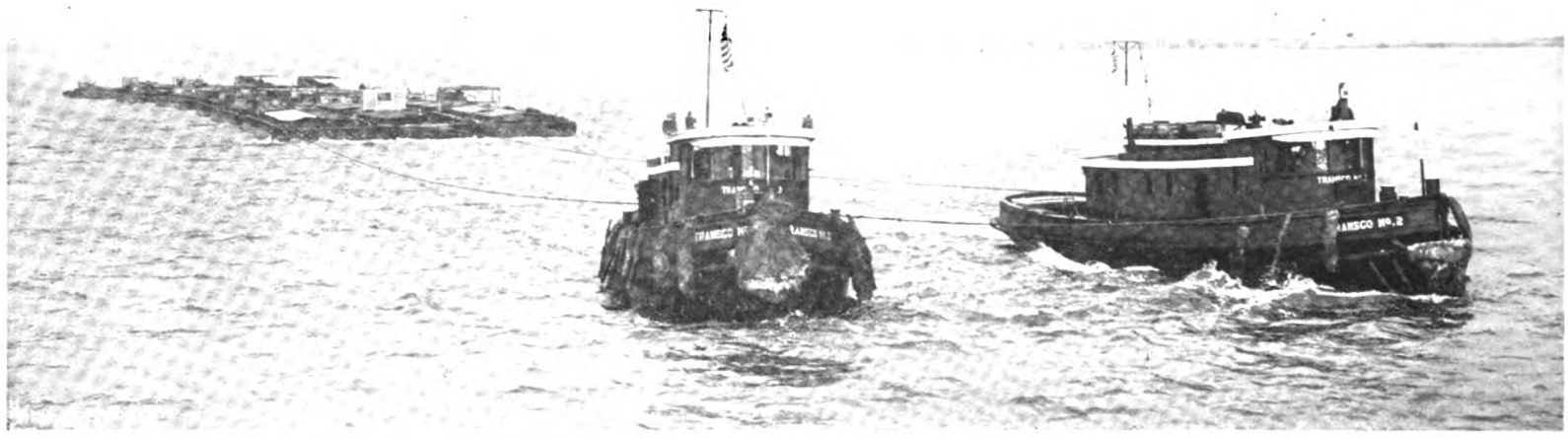
Diesel Fleet in Barge Canal Service

Five Transco Tugs Completing Sixth Successful Season Between New York and Buffalo



Each powered with a 250 *H.P. Nelseco Diesel The Transco No.* 2 *and No.* 3, *described in* MOTORSHIP, *December*, 1923, *continue to go about their business in an efficient manner.*

AN example of the efficiency of the Diesel engine workboat is found in the operation of the Terminal Line's five Diesel powered tugs. This line is one of the largest combinations of terminal and rail-water transportation in the United States. It is said by the owners in connection with the operation of the five Diesel tugs known as TRANSCO No. 1, 2, 3, 4 and 5, that the Diesel tug in comparison with other tugs is cleaner, safer and more reliable in operation. These boats have proven themselves to be most successful and economical.

This is amply borne out by the company's experience in chartering steam tugs for their Canal service. The steam tugs have caused unusual delay while refueling which, added to the excessive cost of operation, makes it impossible for them to compete with Diesel tugs on the New York State Barge Canal.

The Diesel tugs of this line each season cover about 8,000 miles. During this time they tow fleets of five barges which when fully loaded represent about 2,000 tons of cargo. They are in constant operation day and night and the Nelseco engines have occasioned no delay. They are, therefore, entirely satisfactory and highly economical. These tugs have a fuel capacity for 30 days' operation. In one instance one of them covered 1,100 miles without refueling. An example of the unusually heavy loads they tow is the handling of 22 barges with half a million bushels of wheat, representing about 15,000 tons, in one tow; they came down the Hudson in charge of two tugs, the TRANSCO No. 2 and TRANSCO No. 3, each of which has 240 hp.

These are trim little craft built of wood, each 76 ft. in length. They have been thoughtfully planned and carefully constructed to meet requirements of river and canal service. This is merely one more example of the general utility of the Diesel powered workboat

Our inland waterways are assuming an increasingly important place in the general scheme of transportation. This was brought about to a large extent by the introduction of Diesel powered craft. Every person familiar with this subject will recall the deplorable decline in the percentage of water borne commerce on our rivers and canals, while steam, or mules on the tow path, constituted the motive power for river craft and canal barges respectively.

Efficient and economical canal and river tugs have given waterways transportation a new lease on life.

Pilot House Control of Diesel Workboats

THE adaptability of pilot house control to Diesel workboats has been amply demonstrated with a unique remote controlled Diesel engine installation in the pleasure fishing boat FISHER, owned by Schwarzbach Brothers and operated by them, out of Sheepshead Bay, Long Island, N. Y.

A 6-cylinder, 180 hp. Bethlehem Diesel has been installed in the FISHER, and the installation has been so arranged that the engine can be controlled entirely from the pilot house, eliminating the necessity of a constant engine room attendant. A forward and reverse lever is located just abaft the steering wheel. Close at hand, and to starboard of the helm there is a foot button for starting air and a throttle handle for speed control. Conveniently located are the air and oil gages, so that from his place at the helm the captain, alone and unaided, has complete control of the boat.

The FISHER transports fishing parties from Sheepshead Bay to the deep sea fishing banks. In the June issue of MOTORSHIP was printed a full account of the activities of the very interesting fleet of Diesel workboats operating from Sheepshead Bay.

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Diesel Workboats Meet With Favor in Maine

By Alfred Elden

IT was only a very few years ago that the steamboat companies handled practically all the passenger and freight business along the Maine coast. Then came the competition of small power craft on the sea and of motor vehicles on the land. Freight packets economically operated by heavy duty, crude oil motors, now ply between all coastal points reaching out-of-the-way nooks and corners where steamboats cannot profitably go. The latter were undeniably hard hit. Some of the small companies failing to adopt Diesel power have gone out of business. Others have cut down expenses in every possible manner other than to convert to Diesel power and curtailed their service. The ones that still remain are rapidly replacing their steam plants with the modern Diesels.

Some of the earliest activities along these lines were on Maine's large inland waterways. At Moosehead Lake, back in the winter of 1920-1921, the Coburn Steamboat Company tried the Diesel experiment.

Steamers Converted

Originally equipped with compound steam engines and boilers, four steamers have been replaced with Fairbanks-Morse Diesels; the MARGUERITE with 100 hp.; TWILIGHT with 150 hp.; MOOSEHEAD with 200 hp., and the KATAHDIN with 300 hp.

C. F. Woodard, vice-president and treasurer, states, "We have saved a lot of cargo space on account of the compactness of the engine and the discarding of boilers that formerly filled a large space. Economy in operation actually surprised us. Tied up at a wharf a Diesel boat stops using fuel. We have noticed a big saving with the boats that we use for towing log booms in the spring of the year before passenger and freight service start. During high winds a close watch must be kept on the valuable log-rafts. With steam we were obliged to keep up a pressure in the boilers all the time to safeguard against emergeneies. Now our Diesel boats simply lie alongside the rafts without consuming fuel, always ready for duty at an instant's notice.

"Formerly it took us from 45 minutes to an hour and a half to get a steamer ready for service. Now we start when we wish to. And on each of our Diesel boats we have saved a fireman's wages. Our two smaller steamers are used only as stand-bys and will probably soon be out of commission. The two new and larger craft we have in mind will be built for Diesel power."

One Fifth the Cost

The Dieselized MOOSEHEAD makes an 80-mile trip from Greenville at the foot of the lake to Seboomook at the head, and returns at full speed on a total fuel consumption of 120 gallons. When she was a steamer five tons of coal were used at about five times the cost!

Further up in the Maine woods, at Lake Chesuncook, the Great Northern Paper Company has relegated to the discard the old side-wheel steamers used for so many years in logging operations, and replaced them with West Branch No. 2. She was built on the shores of the lake by salt-water boat builders imported from the shore. The tug is 92 ft. by 7 ft. 6 in. and has a 360 hp. Diesel weighing 30 tons. It was quite a task to transport this mass of machinery to its destination. It was carried by railroads to Greenville, there loaded aboard a scow and towed a dozen miles up the lake to Lily Bay. There it was transferred to a specially constructed eight-wheel trailer, and taken in tow by one of the Great Northern's big motor trucks. It was thus hauled 40 miles through the wilderness over company roads to Chesuncook Dam and installed in the WEST BRANCH NO. 2. Since going in service its enthusiastic engineer says he can place a full glass of water on the cylinder head and not a drop will spill over at two-thirds speed, so free is the boat from vibration. Great saving has been effected in the cost of operation compared with the old steam tugs, in fact she is more efficient from every angle.

Ready for launching. Salt water shipbuilders built her according to seagoing standards

Most Eastern Ferry Service

AFTER 36 consecutive years of daily ferry service between the two extreme Easterly seaports of U. S.—Eastport and Lubec, Maine—the old boat LUBEC was taken off the route last December and a new and smaller motorboat, having the same name, is now in daily use, having been launched and placed in commission very soon afterward. The new LUBEC is 53 feet length, 15 feet beam, 4½ feet draft, equipped with a F-M crude oil Diesel engine of 40 hp., speed 10 knots. She was built at Pushee's yard at the historic town of Dennysville, Me., 18 miles from Eastport.

The original LUBEC was built in Portland, Me., nearly 38 years ago, then equipped with steam boiler which was replaced with a 100 hp. F-M crude oil Diesel engine 12 years ago, with speed of 10 knots, and carrying 300 passengers. The Passamaquoddy Ferry Company, established nearly fifty years ago, was purchased twelve years ago by Ralph Hindley of Darien, Conn., who has fishery interests at North Lubec, 2 miles away.

A motorboat was built in 1919, the NOMAD of 42 feet length, 14½ feet beam and 5 feet draft, equipped with a 28 hp. 4-cycle gas engine, carrying 100 passengers, and speed 8 knots, and these two motorboats now handle the ferry business at Maine's frontier coast. When it is considered that it is over 40 miles over country roads between Eastport and Lubec and only 3 miles by ferryboat the great value of motorboats making several round trips daily can be seen, and stops are also made at the 11 mile Canadian island of Campobello, New Brunswick, nearly 2 miles across Eastport harbor, where nearly one thousand people make their homes at two fishing villages.

Until recent years the ferry company secured each four years the U. S. mail contract at $4,000 a year to carry mails twice daily between Eastport and Lubec.

Lubec, the farthest east ferry boat in the United States

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Among Pacific Coast Diesel Craft

California

The Matsuki & Suguzama Company is having built an 85 ft. tuna and sardine boat at San Pedro to be equipped with a 450 b.hp. Western Enterprise Diesel.

A Diesel pilot boat, to cost $20,000 and to be completed early next spring, is to be built for the Harbor Board, San Diego, as soon as plans can be completed.

The Vail Company of San Pedro and San Diego, is having plans drawn for a tuna and sardine boat, probably to be built at San Pedro, to be driven by a 300 b.hp. Western Enterprise Diesel.

A. Paladini, Inc., of San Francisco, has ordered from the General Engineering and Dry Dock Company of Alameda a 78 ft. deep sea fishing boat, a sister ship to the CATHERINE PALADINI. The new boat is to be driven by a pair of Atlas-Imperials of 200 b.hp. each.

The Yuba Manufacturing Company of Marysville is building a very large Diesel-electric dredge to be used for tin mining in the Orient by the Anglo-Oriental Mining Company, and to cost $600,000.

Dr. I. W. Robbins, of Palo Alto, has taken delivery on a 50 ft. stock cruiser, designed and built by the Olympic Motor Boat Corporation of Seattle, and powered with twin 90 b.hp. Cummins Diesels. This is one of the first of the boat building corporations to offer stock Diesel driven craft.

Three Diesel driven pleasure craft, one a 65 ft. schooner rigged auxiliary, to cost $20,000, and the other two power cruisers to cost $16,000 and $25,000, respectively, are being built by Fellows & Stewart. The Whiting yards are building a 50 ft. Diesel cruiser for Larry Kent, motion-picture director. Garbutt & Walsh have a 40 ft. auxiliary sloop well along. The season is the heaviest, both in number of boats building and their value, ever experienced by Southern California yards.

More than half of the 55 motorboats either under construction or ordered from Southern California yards this fall and winter, will have Diesel power, according to Mr. Shuck, prominent Los Angeles Harbor naval architect, who has completed recently a survey of boat building on this coast. Among those to be completed soon is J. F. Logel's 80 ft. Diesel cruiser, to cost $60,000, now about to be launched at the Harbor Boat Building Company's yard. She is to be equipped with two 150 b.hp. Union Diesels. Plans for another 80-footer of similar cost and similar power are also under way.

More than sixty per cent of the owners of Diesel powered cruisers and auxiliaries in Southern California waters are keeping their craft in commission until February or March and then giving them only two months of rest until May.

A number of small Diesel powered day cruisers have been built in the last two years on the Pacific coast for the use of beach real estate companies for showing their properties from the seaside and for fishing trips for prospective customers. Latest of these is the DOLPHIN, 32 ft. 6 in. long by 9 ft. 5 in. beam and 2 ft. draft. She accommodates 25 sightseers or eight anglers, and is driven by a 16 b.hp. Atlas-Imperial Diesel. DOLPHIN was built at the Monterey Boat Works for the Del Monte Properties Company, and is used at Pebble Beach on the Monterey Peninsula.

Washington

The Atlas-Imperial Diesel Engine Company at Seattle, reports sales of 70 Diesel engines, ranging from 20 to 350 b.hp. so far this year.

The Fishing Vessel Owners Marine Ways, Salmon Bay, have completed two sister seineboats, NORBY and NORTHERN QUEEN, each 65 ft. long by 18 ft. beam by 8 ft. draft, and each driven by a 90 b.hp. Atlas-Imperial Diesel with electric auxiliary equipment.

A splendid Diesel tug recently completed is the R. A. MCDONALD, 44 ft. long, driven by a three-cylinder 75 b.hp. Atlas-Imperial, and built by the Everett Marine Ways, for the Weyerhauser Timber Company, which operates her in and out of South Bay.

The Puget Sound Engineering Works has completed the conversion from gas to Diesel engine of a cannery tender and fishing boat for Captain Paul Luketa. This craft, which has been renamed ANTOINETTE L., has a 3-cylinder 50 b.hp. Atlas-Imperial Diesel.

The sea-going tug THEODORE FOSS, formerly the steam tug SHEILIKOFF, recently converted to Diesel power by the Foss Launch & Tug Company, Tacoma, took a capacity crew of tuna fishermen to San Diego for the winter fishing in Lower California waters.

LINDY is a new halibut fisher, 76 ft. long by 22 ft. beam by 9 ft. draft, which was recently completed by the Fishing Vessel Owners Marine Ways of Salmon Bay. She is schooner rigged, with a 150 b.hp. Atlas-Imperial Diesel installed far aft, so as to be out of the way of the deck fishing gear and winches.

The former government steam tug VIGILANT has been converted into a powerful Diesel craft by the installation of a 500 b.hp. McIntosh & Seymour engine by the Washington Iron Works of Seattle. The tug, which is 117 ft. long, has been renamed GOLIATH.

Construction will start shortly at the Ballard Marine Railway, Seattle, on what will be the largest and most powerful Diesel towboat yet built in this country, to be delivered under her own power to Young Brothers, Honolulu. She is to be 125 ft. long by 28 ft. beam and 14 ft. draft, driven by two 520 b.hp. Fairbanks-Morse Diesels, a total of 1040 b.hp. All equipment, including lighting, refrigeration, cooking, ventilation, anchor windlass and towing winches, will be electric, with power derived from an auxiliary Diesel engine, of size and make not specified. Fuel capacity of 30,000 gallons, with corresponding water tankage, will give the big tug an extraordinarily long cruising radius. Construction will be very heavy, with all timbers pre-shrunk to allow for the tropical sun under which most of the work of this boat will be done.

The refrigerated freighter A. B. CARPENTER, formerly the steam halibut steamer ZAPORA, arrived recently at Los Angeles harbor from the yard of the Lake Union Drydock Company, Seattle, where she was converted from steam by the installation of a 6-cylinder 350 b.hp. Atlas-Imperial Diesel. Her hull is 148 ft. long by 22 ft. beam by 12 ft. draft. She will be operated up and down the coast of Southern California. It will be recalled that the ZAPORA has a legend of interesting events that occurred in her halibut fishing days. She was one of the fastest halibut steamers in the fleet, and fables of her poaching exploits on the British Colombia coast were told in the fo'c'sles of every type of fisherman from the smallest "smoke-boat" to the finest big "company steamers." She had the reputation of never failing to fish "inside the limit" if that was where the fish were most plentiful. It was said that she was sighted time after time by the Canadian patrol cutters, but always escaped, and generally with a good catch. She would "cut the gear," so the stories go, pick up her dories and disappear over the horizon to the delight of her master and her crew, and to the utter disgust of the Canadians. Her new machinery with its superior economy will make of her just an ordinary efficient boat, but it can not bring back the rollicking days when she was queen of the fleet and proud as a ship could be.

Oregon

The Albina Marine Iron Works of Portland is building a 65 ft. Diesel towboat for Captain Milton Smith of Rainier, Ore., to be equipped with a 250 b.hp. Atlas-Imperial Diesel, and to be completed in February.

One of the largest of the new motor tugs of the coast is CHAHUNTA, 80 ft. long, and equipped with two 220 b.hp. Atlas-Imperial Diesels. She was built by the Winslow Marine Railway and Shipbuilding Company of Winslow, Wash., to order of the Lincoln County Tug & Barge Company of Taft, Ore., and is now at work over the Silitz River bar in Oregon. Heavy construction and great pulling power characterize this large tug.

British Columbia

The Island Tug & Barge Company of Victoria, B. C., is building for its own order a boom towboat, the ISLAND SCOUT, to be powered with a 35 b.hp. Fairbanks, Morse Diesel.

The Victoria Tug Company is preparing plans for a seventh Diesel tug for addition to its fleet. This will be the largest motor tug in the Pacific northwest, but description is not yet available, according to Captain A. McGregor of the towing company.

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Courageous Conversion Diesel-Electric Drive

DESIRED Increase of 40% in Ship's Speed Constituted a Unique Engineering Problem

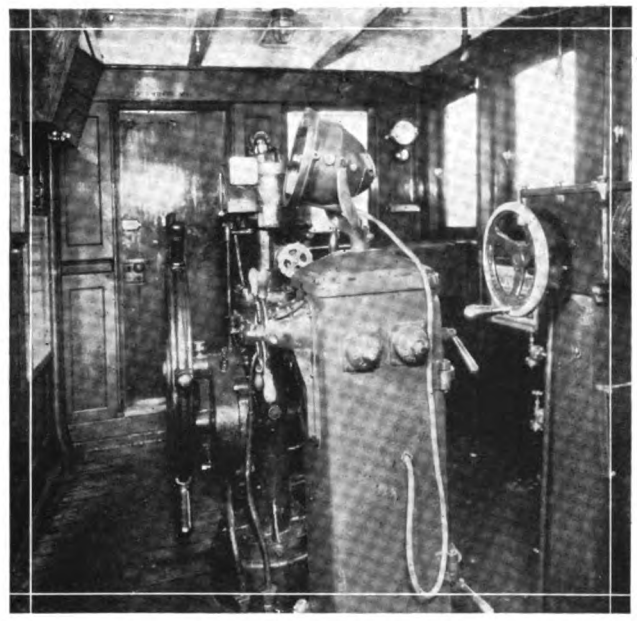
MAXIMUM Propeller Efficiency Was Essential and Dictated Use of 60 r.p.m. at Propeller

BY R. W. CROWLY

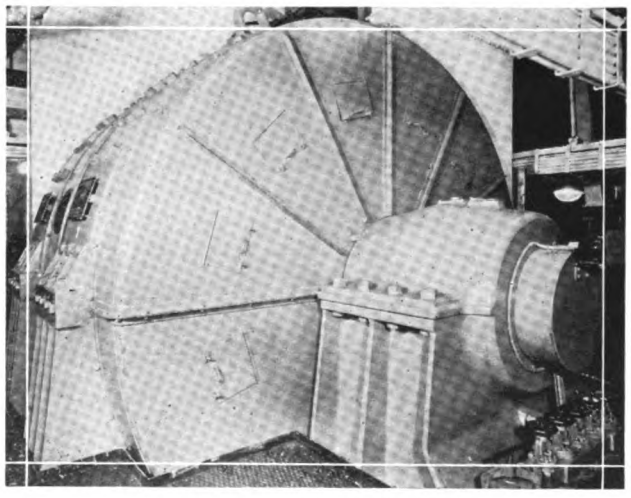
This article is the Introduction to the separate supplement describing the COURAGEOUS, TRIUMPH and DEFIANCE (Part II, December MOTORSHIP)

FOR the conversion of COURAGEOUS, DEFIANCE and TRIUMPH into vessels having a sea speed of 13 knots on full draft the Diesel-electric system seemed to the Shipping Board advisers to present itself as definitely superior to the alternatives and to leave really no room for other choice. This opinion is at variance with the views prevailing at large, but, whereas the grounds for the Shipping Board's opinion can be adduced and analyzed, there is doubt that the critics know what the problem was and that they understand the solution.

Specifically the problem was that the Shipping Board needed 13 knots sea speed in vessels of the class in the Far East service, and the three hulls available for repowering offered a relatively appalling resistance to propulsion at the higher sea speed desired. From the studies initiated it appeared that, if the hull lines were improved as planned, 13 knots plus could be assured by Diesel-electric drive with an aggregate of 4850 b.hp. in the old machinery space for all purposes, whereas with a direct Diesel drive it looked as if an aggregate of about 5650 b.hp. would have to be installed for all purposes, at higher cost, with greater weight, increased fuel consumption and a lower net cargo capacity. It is instructive to fathom this case. The answer is illuminating.



Modern steering and pilot house control equipment of the Courageous.



The main propulsion motor of 4,000 s.hp. at 60 r.p.m. makes a compact installation.

Originally the three vessels were steamers rated at 10 knots sea speed, but fully laden they could not be depended on to exceed 9½ knots. Bluff-bowed and box-like, with a high coefficient of fineness and a high block coefficient — typical of the freight tonnage built under the wartime ship construction program—they had very different lines from those given to vessels expressly designed for 13 knots sea speed. Yet this higher speed was the minimum required to meet the competition of the new foreign motorships on the route where the other Shipping Board steamers of this same design were in operation.

COURAGEOUS, DEFIANCE and TRIUMPH belong to a class of 11 steamers of the S. B. Design No.

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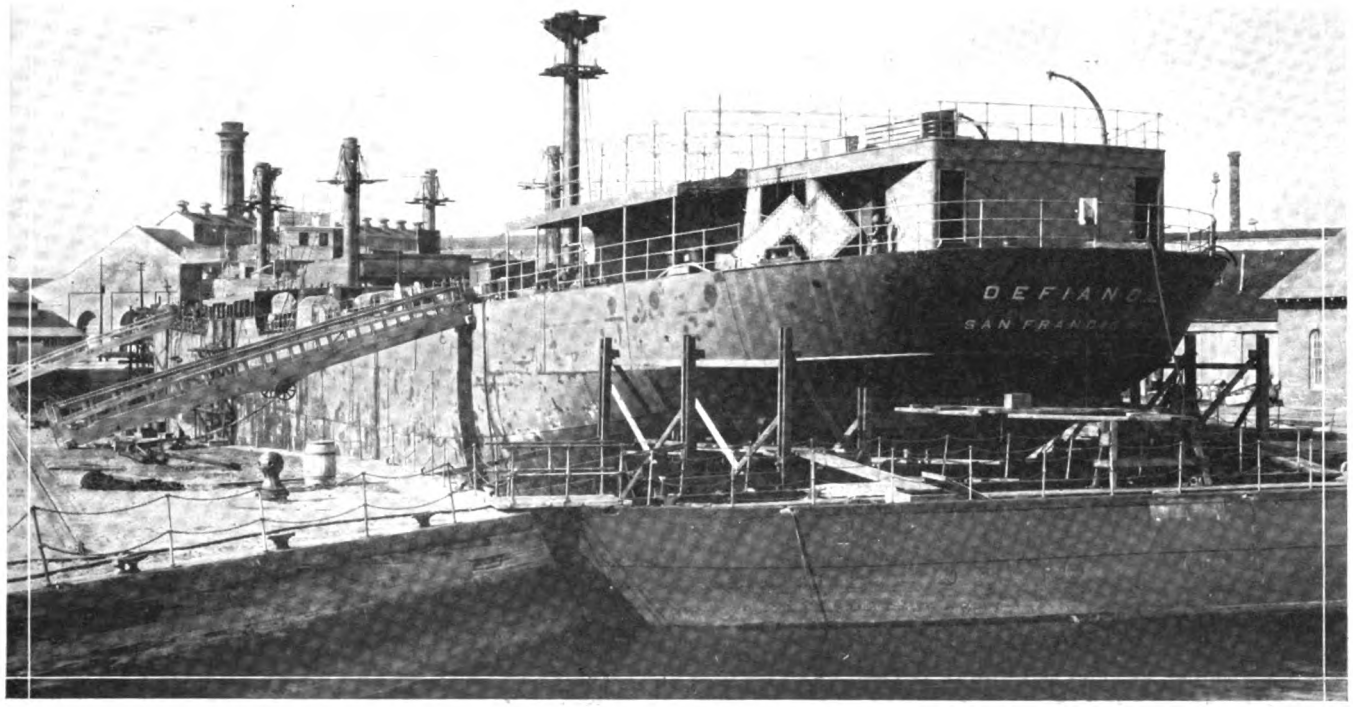

The Defiance was assigned to the Norfolk Navy Yard for Conversion.

1032. Together with the Steamship STEADFAST they were built with geared turbines of 2645 s.hp. Five others, ARCHER, ECLIPSE, INDEPENDENCE, INVINCIBLE and VICTORIOUS, had turbo-electric machinery of 2900 turbine shaft horsepower. The remaining two, HEGIRA and HEFFRON, had triple-expansion engines of 2720 i.hp. All had about the same speed and a displacement of about 16,000 tons with the free-board originally assigned to them. On that basis the dw. c. measurement was about 11,770 tons and the net cargo capacity about 10,000 tons with fuel tanks full. The cubic measurement for bales was about 586,000 cu. ft. in all the turbine vessels, but slightly less in the vessels with reciprocating engines. In operation the reciprocating-engined boats were best; the turbo-electrical qualified for operation, and the geared turbines were laid up after a few voyages.

The vessels of this class retained in service are now allocated to the American Pioneer Line, which operates in two divisions between North Atlantic and Gulf ports, respectively, and the Orient and Dutch East Indies. Keen foreign competition has developed in this service, particularly in the Atlantic division since the fleets of Prince liners rated at 14½ knots and of Silver liners rated at 14 knots, all being most modern motorships and all operating under a foreign flag, slashed about a week from the time of the passage.

Several years ago the Shipping Board saw this competition coming, but what could it do, lacking authority and funds to build fast new motorships as the best reply to the competition? Abandonment of the berth was beyond consideration because the maintenance of an American service on such an important route is precisely the Board's duty. It has tried to sell the Line, but without avail, although offers have been made for the motorship WILLIAM PENN, rated at 11½ knots, which operates on the route alongside the steamers. The only course open was to accept an inferior position on the route and improve the equipment on this berth so far as the balance of the Conversion Loan Fund permitted.

Admiral Wm. S. Benson, who was then in charge of all matters pertaining to the physical condition of the government's mercantile tonnage, realized full well the handicap of unfavorable hull form in all the Diesel conversions. These vessels may be likened to boxes with a blunt wedge for bow—the natural response to the wartime cry for "deadweight" and "cubic." He knew that to get 13 knots sea speed out of the laid-up vessels of class No. 1032, would demand an almost prohibitive increase of power, due to the wavemaking proclivities of the blunt entrance and to the eddymaking form of the full stern. How far this handicap could be lessened by a reasonable expenditure of money he put up to Admiral Taylor (Ret'd.), former Chief of the Bureau of Construction and Repair in the Navy Department and to William Francis Gibbs, naval architect of New York. The experiments and subsequent conversions have been carried out under their direction and supervision.

From experiments with models in the Navy tank at Washington, Admiral Taylor deduced that by lengthening the vessel 11 ft. the lines at the bow could be fined sufficiently to yield a worthwhile decrease of wave making resistance, which in conjunc-

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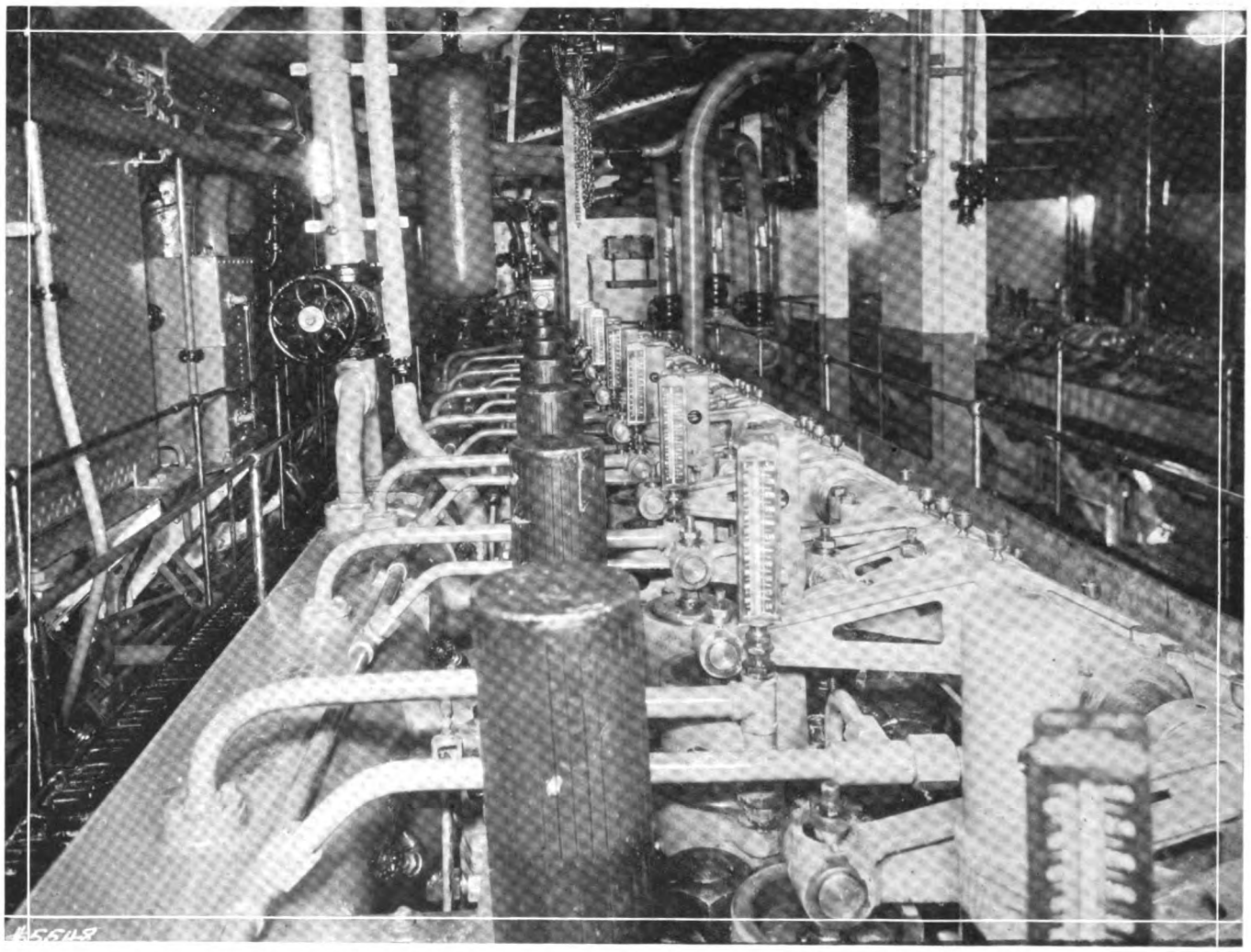
tion with the utmost possible increase in the efficiency of the propulsion by the use of a slow-turning propeller of maximum diameter and with streamlined elements adjacent to the propeller aperture, would render a sea speed of 13 knots much more reasonably attainable. The load waterline aft is lengthened about 11 ft., considering the new waterline to extend to the after end of the streamline rudder.

To Admiral Taylor a slow-turning propeller for a 13-knot vessel meant considerably fewer shaft revolutions per minute than prevailed in the direct-drive installation of the Shipping Board's 11-knot motorships, none of which registered less than 95 revolutions per minute. One can easily figure the approximate speed required for maximum propeller efficiency in COURAGEOUS and her sisters. In the converted vessels the propeller diameter could be increased to nearly 22 ft. after alteration to the stern. The basic theory of screw propulsion indicates a blade angle of 45 degrees for maximum efficiency. In practice this has to be empirically adjusted, but for the sake of simplicity let us deal only with 10 per cent for slip, and plain arithmetic then shows that for 13 knots speed the corresponding revolutions would be 66 per minute. This elemental calculation serves to emphasize how far below the practise in direct-drive Diesel installations are the propeller revolutions required in this case for maximum propeller efficiency. Of course Admiral Taylor's propeller calculations would be made with precision and would embrace empiric factors and values known to him by virtue of long experience.

In the final design for the conversion of these three vessels a propeller speed of 60 revolutions per minute was adopted. The only oil engine within reasonably close accord with this speed is the Doxford type. The fact is that in most Diesel engines advantage is taken of the altered attitude towards propeller speeds that was created by the steam turbine. Since reciprocating engines have been pushed to the rear in new construction, propeller efficiency has been sacrificed to a compromise with the higher speeds which the builders of machinery favored to help them in their problems. The effect is seen, for instance, in the disappointingly narrow margin of economy which freighters with turbine machinery show over steamers with reciprocating engines. The marine turbine does not yield the superior economy



Since the engines are not high there is ample headroom above them; a condition at once apparent in this view of the port wing engine of the Courageous.

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which the land turbine gives, and it is undeniable that fashion or vogue more than real economy fostered the use of the turbine for freighters.

Proper propeller speed is much more of a factor in ship speed and in economy of power than the marine world seems to recognize today. On that point the old school was better posted than the men of our present time. It is a very important influence in the results secured by the conversion of COURAGEOUS, DEFIANCE and TRIUMPH. It also has a great significance for the future of Diesel-electric drive, because it emphasizes that the way to maximum propeller efficiency and the way to cheaper Diesel engines are simultaneously opened by this system, the former through the electric motor and the latter through higher speed and lighter weight.

Comparing Direct Drive

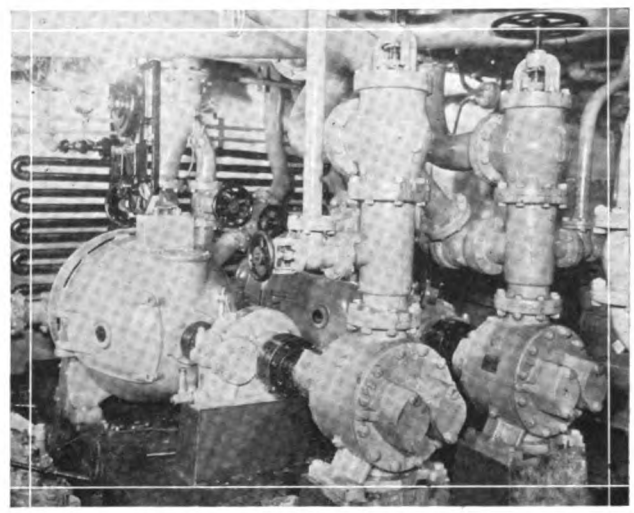
Leaving on one side in the next few paragraphs the importance of maximum propeller efficiency, one may get a line on what might have been expected with direct-Diesel drive in COURAGEOUS, DEFIANCE and TRIUMPH by turning to the results obtained in the direct-drive motorships already converted for the Shipping Board and to the results that may be anticipated from the vessels marked for conversion. In taking this line one must remember that the increases of speed attending the conversions have had to be obtained against the handicap of the box-like hull forms, and when viewed in this light they are very creditable.

Average costs will be quoted, which include vessel improvements, repairs, outfitting, inspection, etc., in addition to the machinery alterations. Information is not publicly available for breaking out these items from the totals, but the comparison below is not vitiated by their inclusion owing to the items being almost common throughout. The only warning necessary is that these items boost the total costs probably 33 per cent higher than the costs of mere Diesel conversion.

Averaging the first group of S.B. converted vessels, it seems that for an expenditure of $810,000 a sea speed of 11 knots loaded was obtained with a ship of 9125 tons dw.c. having an aggregate engine power of 3400 b.hp. for all purposes and a machinery weight of about 650 tons. The second group will apparently average about $1,030,000 for a sea-speed of 12 knots in a vessel of 9400 tons dw.c. having an aggregate engine power of 4850 b.hp. for all purposes and a machinery weight of about 850 tons.

Herefrom it appears that for a vessel of 10,500 tons dw.c. converted on the same general plan of direct drive, but with a sea speed of 13 knots, the aggregate engine power required, would be of the order of 6500 b.hp. with a machinery weight of about 1100 tons, and the conversion cost would be about $1,350,000. Yet COURAGEOUS, which is exactly such a vessel of 10,500 tons dw.c. with a speed of 13 knots, has required with the Diesel-electric system an aggregate engine power of only 4850 b.hp. with a total machinery weight of 930 tons, and her conversion has been completed for a contract price of $1,319,000.

Seen from this angle the Diesel-electric system in COURAGEOUS, DEFIANCE and TRIUMPH can be viewed in approximately correct perspective. It appears as a comparatively superior operating system obtained at about the same capital cost as the direct-drive motorship, provided the average figures quoted above are rational. An independent check can easily be applied by interpolation of the ratios set out in



Lubricating oil pumps of the Courageous electrically driven through reduction gears.

a statement issued two months ago by the National Council of American Shipbuilders to elucidate the effect of speed on the cost of ship construction. Taking into account that the power of the machinery must increase faster with higher speed in converted vessels than it does in new vessels—because the block coefficient cannot be reduced in the former as it can be in the latter—the three sets of figures above, relating to direct-drive conversions, seem to be in proper proportion when submitted to this check.

Aggregate Machine Power

An important matter to be noted in examining these figures is that aggregate machinery power is used in all the examples. It is necessary to totalize the power of the main and auxiliary engines in order to give the proper slant on the machinery weights and in order to bring out the feature that separate auxiliary sets are practically abolished in the Diesel-electric installations.

For instance the first group of direct-drive conversions in the Shipping Board program averaged 2900 s.hp. in the main engines and more than 500 b.hp. in the auxiliary sets, a total of 3400 b.hp. In the second group of S.B. direct-drive conversions the main engines average 4000 s.hp. and the auxiliary sets 850 b.hp. It has been deduced that a

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direct-drive conversion to 13 knots without hull alterations would require 5650 horsepower on the main shaft and 850 b.hp. for the auxiliary sets. The corresponding prices are all based on the retention of the original hull lines, which has been the practice in the direct-drive conversions.

Against this one finds the COURAGEOUS, after conversion to Diesel-electric drive, with an aggregate of 4850 b.hp. in the engine room to serve all main and auxiliary power purposes. There are four principal engine sets of 4800 b.hp. total, from which at sea about 4500 b.hp. will be taken for the 4000 s.hp. electric propulsion motor, leaving a balance of 300 b.hp. for auxiliary purposes, fully ample for sea needs. In port, any of the four principal engine sets can be used to deliver whatever power is required. The only real auxiliary set is a 55 b.hp. (36 kw.) Diesel-generator-compressor unit for service when the port load is reduced. This advantage is not exposed unless one totalizes all the power in the vessels.

Less Engine Power Required

There remains the question of the cost of a direct-Diesel drive in conjunction with altered hull lines. Obviously the shaft horsepower required would be considerably greater than with the electric drive, because the Diesel engines available are those of the type used in the second group of conversions and turn at 115 r.p.m. or more, contrasted with the maximum efficiency propeller speed of 60 r.p.m. It is unlikely that the difference in propulsion efficiencies at these two respective speeds is less than 20 per cent. If one favors the direct-drive with that minimum figure then the shaft horsepower would have to be not less than 4800, which, plus 850 b.hp. for auxiliary sets, would make an aggregate of 5650 b.hp. At the Shipping Board purchase price this would effect a saving of $63,000 to which should be added a sum for proportionate reduction in the cost of installation. Actually the cost of bow and stern alternations in the COURAGEOUS group may be estimated as $150,000. In capital cost therefore the previously estimated figure of $1,350,000 for direct-drive conversion would not be reduced by the decreased power requirements, but would be increased if the hull lines were altered. A decreased operating cost would thereby be obtained, but apparently still above the operating cost of the Diesel-electric drive.

When duly considered, the conversion of COURAGEOUS, DEFIANCE and TRIUMPH to a Diesel-electric system of propulsion is thus seen to be indicated as cheaper than a conversion to direct Diesel drive. One need not insist strictly upon the figures cited above. Even if the Diesel-electric system represented the same capital investment, it has other advantages. The gain of about 20 per cent in propulsion efficiency overwhelms the loss of about 10 per cent power in the electric transmission. The favorite figure of the electric drive opponents is 15 per cent power loss, but that is an exaggeration in the vessels under consideration. The plain fact is that as between direct Diesel drive at 115 r.p.m. and the electric drive at 60 r.p.m., the honors for straight efficiency go to the electric system. That is categorical here, and it makes hash of most domestic, and all foreign, comment. Yet what is true in the case of COURAGEOUS, DEFIANCE and TRIUMPH cannot be universally applied. Each other case must be examined on its merits. Also the conditions must not be rashly assumed as equal between Diesel-electric and turbo-electric drive, because apart from the unequivocally cheaper operating cost of the appropriate Diesel installation—turbine proponents are hopelessly confused on this point—the Diesel engines permit economy over the whole range of operating power.

Thus, at full power the four Diesel engine sets will be running on the flat high part of their fuel economy-curve; at three-quarters power, three Diesel engine sets will turn with equal economy; at half-power, though only two Diesel engine sets are operated, the economy is undiminished; and still at quarter-power, the economy of the Diesel engine operation is the same as at full power. That is far from being the case with the turbine unit of a turbo-electric system, though it is true that when the turbo-electric installation is powerful enough to justify the use of two turbines, the full economy can be obtained at half-power, but of course, not at other loads. The contention that this particular advantage of the Diesel-electric system is more theoretical than practical is wrong, because it is an almost invariable habit of chief engineers of steamers —on express Atlantic liners as on freighters—to drop the power a little for the purpose of showing a fuel saving, and that reduction of power cuts right into the best figures of the turbine. There is extremely little full power operation of steamers. This is the big hokum of turbine operation: reduce the power to conserve fuel in the tanks and spread the reduced fuel consumption over the rated shaft horsepower of the turbine—result: fancy figures and glory for the engineer, bunk and deception for the owner. The Diesel-electric ships are on the same footing as the ordinary motor ships in one respect, that their economy removes the temptation to reduce the power; they burn relatively so little that there is little to be saved. And that is why the big operators of motorships are all able to endorse the statement that motorships show a better maintained speed than steamers and demonstrate a maintained economy.

Economy at Reduced Speed

As between the Diesel-electric drive and the direct Diesel drive the questions of economy at reduced power and the maintenance of speed are largely a matter of weather. The Diesel engine holds its economy pretty well even at half power,

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so that as between a direct-drive Diesel at half power and two Diesel-generating sets at full power there will be little difference except in prolonged operating conditions of that sort. Similarly in regard to the maintenance of speed, while undoubtedly a large propeller turning at 60 r.p.m. will hold a ship up to her speed better in a moderate sea, there is no difference in fair weather. The year round in the Eastern trade, the Diesel-electric ship will have slightly the better of it.

From the subdivision of the power into multiple units the Diesel-electric system derives, however, a very great advantage in respect to maintenance. In COURAGEOUS, DEFIANCE and TRIUMPH the machinery consists of four independent trunk-piston engines with oil-cooled pistons, rated on the basis of 90 lb. per sq. in. mean indicated pressure and 1000 ft. per min. piston speed, turning at 250 rev. per min. Such engines are practically the A B C of Diesel design and as simple to tend as can be. Thousands of engines of their cylinder size and speed are in operation throughout the world, many of them in remote places and under the care of uneducated attendants. There ought to be very few repairs on them. Routine changes of valves and centrifuged oil should keep them free from maintenance until, after a long interval, new piston rings or fuel pump parts have to be taken out of stores, or bearings have to be set up. Drawing pistons for inspection, cleaning the rings, setting up crossheads, adjusting shims, etc., and all the other usual details of port work do not properly belong to this size and type of engine. When the time does come to draw pistons or set up bearings, there is no back-breaking work as there is on the big direct-drive engines. If some fool thing on one of the engines should go wrong at sea, the ship loses little time while the engine is shut down for the elimination of the trouble. There is certainly less maintenance altogether; fewer stores are used; repairs should be reduced to a minimum; and the decreased work to be done is of a relatively light character because there are no heavy parts in the engines.

American Ideas

This feature is one of the most valuable assets of the Diesel-electric drive. There is no doubt about it. It is one of the main reasons why the Atlantic Refining Company of Philadelphia ordered Diesel-electric drive for its new foreign-flag tankers to the amazement—and ignorant amusement—of shipping circles abroad, who could interpret it only as another of what they are so pleased to call crazy American ideas. In the Atlantic Refining tankers this valuable feature of decreased maintenance is very pronounced by reason of a smaller cylinder diameter, natural piston cooling and airless injection. When a true appreciation of the economy resulting herefrom percolates into shipping minds the Diesel-electric system will come to be viewed on a broad, openminded basis instead of in the narrow prejudiced way chiefly prevailing now.

There is a time coming when the number of men in the engineroom of a Diesel-electric ship will be adjusted to the reduced attention demanded by the machinery, but this change will come slowly. In the converted COURAGEOUS, DEFIANCE and TRIUMPH 12 men are still carried on the engineroom payroll. The pilot-house control of propulsion is tied up with this question, and a long time will pass before the young and old generations of today will be ready to accept the change.

There are other benefits of Diesel-electric drive which are brought out in their respective connections in the succeeding chapters of the supplement. Some of them are very important, such as the inducement to adopt faster-running engines and thereby reduce the price, the encouragement of volume production by the use of more numerous engines of smaller power—the biggest help of all towards lower prices for machinery—, the saving of interest on capital during construction by virtue of quicker machinery deliveries, the standardization of engine stores in a big fleet by the use of one size and type of machinery unit in such multiples as needed for the different powers of vessels, the banishment of engine erection in the vessel, etc., etc., all tending towards desirable simplification and economy.

A Superior Operating Unit

In this article detailed exposition has been given only to the principal reasons that determined the choice of the Diesel-electric system for the conversion of COURAGEOUS, DEFIANCE and TRIUMPH. It has been shown that a superior operating unit has thereby been obtained than could have been had with any form of steam or even with direct Diesel drive for the same capital investment. That was the all-important consideration, and it determined the decision of Admiral Benson and, through him, of the Shipping Board.

All of the principal details of the Gibbs conversion are described and illustrated in the succeeding pages of the supplement.—MOTORSHIP Part II, December issue.

As a result of the conversions the Shipping Board acquires for competitive service in the Atlantic division of the American Pioneer line, under the management of the Roosevelt S.S. Co., three vessels with what we have called a sea speed of 13 knots, but which in all likelihood will prove to be in excess of that speed on full draft. In point of speed over the long passages between the North Atlantic range and the Far East ports the difference between these three vessels and the Prince liners or Silver liners will probably be too small to count for much. Only by conversion of three steamers into motorships could the Board effect this improvement in the service. There was no other way, and the improvement was essential.

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DIESEL-ELECTRIC SHIPS

COURAGEOUS

DEFIANCE & TRIUMPH

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Characteristics of the Courageous Changed by Rebuilding

CONVERSION and Reconditioning Have Changed This Obsolete 9½-Knot Freighter, and Her Two Sister Ships Triumph and Defiance, Into Modern 13-Knot Diesel-Electric Craft That Set a New and Higher Standard for American Freight Vessels.

WHETHER in agreement or not with the bold step of lengthening and converting the COURAGEOUS, TRIUMPH and DEFIANCE to a form of propulsion hitherto untried with cargo vessels of their large size, shipowners must necessarily watch the service performances very closely. For these vessels may—and very probably will—have a tremendous influence on freighter construction, just as the Atlantic Refining Co.'s Diesel-electric tankers may effect bulk-oil carrier design. The tendency today is for higher powers and higher speeds, supplanting full-lined slow freighters with bigger and faster cargo-liners capable of running on timetable schedules, and capable of carrying a limited number of passengers. This the Diesel engine, with its economical fuel consumption and consequently small bunker need, has made possible and practical.

The conception of Diesel-electric drive, with its smaller, faster-running power units in conjunction with even slower propeller speeds than heretofore, for one thing renders feasible higher powers and higher ship speeds, without materially increasing standard Diesel engine sizes. Thus larger cylinders and other parts are avoided. Far seeing naval architects can readily grasp the fact that the 15-knot and 16-knot cargo-liner is very, very close at hand.

Had the COURAGEOUS and her sisters been specially designed and built, the advance in shipbuilding would have bordered on radical, so great would have been the change. But in this Supplement we will confine ourselves to the facts. Congress would not permit new construction. Such material as was available had to be taken by the Board and moulded into shape, i. e., by remodeling and repowering existing obsolete steam ships that had been built for smaller powers and lower speeds and with the ruthless disregard of fair lines so noticeably absent from much of the war-built tonnage.

While still a Commissioner of the Shipping Board, Admiral Wm. S. Benson had the vision to see the merits of the Diesel-electric conversion plan which he proposed and had the courage to force the proposal into definite action in the face of caustic criticism and strong opposition from many influential quarters.

In the COURAGEOUS we now have a ship that can maintain over 13 knots—not a fast ship in these days of cargo motorliners, but nevertheless very much faster than the 9½ knots her original design gave her. She can handle loading and discharging cargo at a very much higher rate than before on a greatly reduced fuel consumption, so is far more efficient in port. Her hull and Isherwood framing are in excellent shape. Her engine foundations are considerably stronger and heavier than before. So she is good for at least fifteen years of service. Before conversion she was useless and inactive, and would have remained so until scrapped. It cost about a million and a quarter dollars to convert her. It would have cost an additional three hundred thousand dollars for a new ship. As the Administration and Congress would not permit of the latter, it is of no use to say that a new ship would have been far more efficient. Besides, everyone knows that, and a new ship would still leave the Board with an obsolete hulk that nobody wanted. Under these circumstances the conversion is justified. Results in service are calculated to support this belief. These remarks also apply to the DEFIANCE and TRIUMPH.

Before proceeding further let us quote the general dimensions, power, etc., of the COURAGEOUS, before and after conversion, at the yard of the Federal Shipbuilding and Dry Dock Company, Kearny, N. J. The changes must be studied in the light of the particular conditions of the trade in which she will operate, viz., North-Atlantic—Philippines—S. China.

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General Specification Courageous

1. *For the practical interpretation, as distinct from the academic interpretation, of the comparison below, the following points must be understood:*

2. *Courageous is capable of carrying substantially the same amount of cargo in the Eastern trade now as before her conversion, notwithstanding the increase of sea speed from 9½ knots to 13 knots.*

3. *Bale capacity and the bunkering practise in the Atlantic division of the American Pioneer Line annul the "apparent" disadvantage of the reduced net cargo capacity shown for the fully bunkered condition.*

4. *These conditions were taken into account in the proposal to lengthen the vessel, a procedure entailing increase of freeboard and therefore decrease of load draft. Reduced draft after conversion should be noted when looking at tonnage figures.*

5. *For trades in which weight cargo might be the rule, the conversion plans could be arranged to suit such conditions.*

	Before Conversion	*After Conversion*
Length—overall	457 ft. 6 in.	468 ft. 6 in.
Length—between perpendiculars	440 ft. 1½ in.	457 ft. 4½ in.
Breadth—moulded	56 ft. 0 in.	56 ft. 0 in.
Depth—moulded	38 ft. 0 in.	38 ft. 0 in.
Draft—loaded summer	28 ft. 7½ in.	27 ft. 4 in.
Displacement (loaded)	15,946 tons	15,140 tons
Displacement (light)	4,078 tons	4,640 tons
Cargo Capacity (grain in holds)	577,992 cu. ft.	577,992 cu. ft.
Cargo Capacity (bales)	579,602 cu. ft.	576,765 cu. ft.
Net cargo capacity (with fully bunkered condition)	9,400 tons	9,128 tons
Bunker capacity (including deep tank in steamer)	2,138 tons	1,159 tons
Fresh water capacity	235 tons	213 tons
Dead-weight capacity (including fuel, water and stores)	11,773 tons	10,500 tons
Machinery weight (including aux. propeller and shafting)	——	928 tons
Power (main engines)	2,645 s.hp.	4,000 s.hp.
Type of machinery	Geared turbines and Scotch boilers	Diesel-electric
Daily fuel-consumption (main and aux. engines at sea)	35 tons	21 tons
Length of passage on full bunkers	13,900 sea miles	17,270 sea miles
Daily fuel consumption (in port)	14 tons	3 tons
Donkey boiler consumption (at sea in winter)	nil	1 ton
Sea speed	9½ knots	13 knots
Propeller speed	80 r.p.m.	60 r.p.m.
Make of engines	General Electric	McIntosh & Seymour
Make of electric equipment	——	General Electric
Length of machinery space	65 ft. 0 in.	65 ft. 0 in.
Length of main Diesel engines	——	32 ft. 0 in.
Weight of each main engine	——	60 tons
No. of men in engine and boiler rooms	17	12

RELATIVE TRANSPORTATION CAPACITY

M. S. Courageous	*At Sea*	*In Port*	*Year's Mileage*	*Performance*
Before conversion	210 days†	155 days†	48,000 miles	100 per cent
After conversion	189 days	176 days	59,100 miles	123 per cent

†Assumed basis for comparison.

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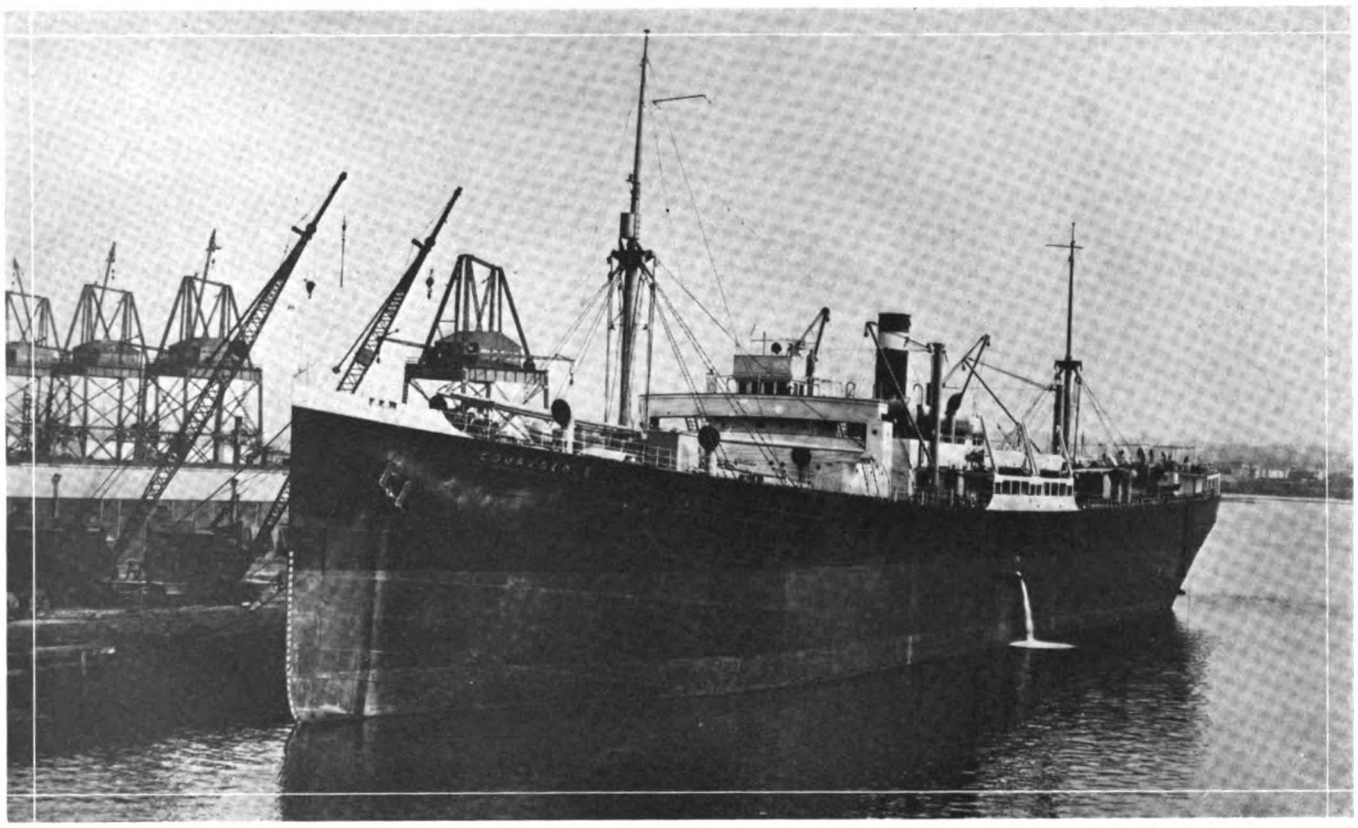
Careful analysis of the comparative figures reveals many things not visible on the surface. In the first place the speed has been increased by 3½ knots, or to 312 nautical miles from 228 per day. This has not been accomplished with an increase of fuel, but actually with a daily saving of 14 tons per day of oil at sea. The lubricating oil consumption will be increased by about 10 gal. per day but this cost is more than offset by the big reduction of fuel in port, especially in summer or in warm climates. This port fuel saving will be about 11 tons of fuel per day. Despite the higher power and faster speed, the number of the engine-room crew has been reduced from 17 to 12—a saving of five men.

in running on a mixture of Diesel oil and boiler-oil, or on the latter if circumstances demand it. The dominant point is that she now makes a much higher speed on a smaller fuel bill while her earning power over a ten-year period is very much higher by reason of the greater number of voyages now possible.

The propelling machinery is located amidships in the space that was occupied by the old steam machinery. It consists of one double-armature propelling motor, four Diesel-generator units with attached exciters, two ventilating fans for the electric propulsion equipment, and one main switchboard. There are one auxiliary Diesel-generator unit, one



After the work of conversion was finished, Courageous remained at the Federal Yard while dock trials were carried out.

When the cargo is of a heavy nature the COURAGEOUS will be able to handle a greater net load on a long run at full draft, because she can cruise over 17,000 miles at 13 knots on her bunker capacity of 1159 tons, whereas the 837 tons deep-tank capacity would have had to be used before, and so encroaching on her net-cargo load. As a motorship the deep-tank can be turned over to 28,635 cubic ft. of cargo. Besides there no longer is need for a large quantity of fresh water for boilers. The small quantity now carried does not interfere with dead-weight cargo. These things, of course, depend largely upon the nature of the cargo, and the distance of the voyage. Fuel costs will depend upon what grade of fuel is selected by the Board or operators. As she has oil centrifuges she should have no trouble

auxiliary switchboard, and the usual engine-room auxiliaries. All the pumps are motor driven except the donkey-boiler feed pump, which is steam driven. All the electrical main propulsion equipment and the motors for the auxiliary machinery were supplied by the General Electric Company.

Of the double armature type the main propulsion motor is totally enclosed and forced ventilated. It has a normal output of 4000 s.hp. at 60 r.p.m. and is capable of delivering a maximum of 4500 s.hp. Each armature operates with direct current at 750 volts. The motor can be controlled either from the pilot-house or from the engine-room through the Ward Leonard system of control. A 41½" two-shoe thrust bearing is located abaft the main motor in a separate casting.

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The four main Diesel engines were supplied by the McIntosh & Seymour Corporation. They are of the four-cycle, single-acting, air-injection, trunk-piston type. Each engine has eight cylinders, 20 in. dia. x 24 in. stroke developing 1200 b.hp. normal, and 1320 b.hp. maximum, at 250 r.p.m. They are described elsewhere in this Supplement. Starting air for these engines is stored in four flasks at 1000 lbs. per sq. in. These flasks are connected directly to the engines through reducing valves which reduce the pressure to 400 lb. per sq. in.

Each engine drives one 800 kw. generator and 100 kw. exciter. Generators and exciters are of the totally enclosed, forced ventilated type. Direct current is supplied by the generators at 375 volts, and by the exciters at 240 volts. Particulars are given in detail elsewhere in this Supplement.

The two ventilating fans are located above the engine-room at the bridge deck level. They are of the multivane, double-inlet type manufactured by the B. F. Sturtevant Company. Each fan has a capacity of 35,000 cu. ft. per minute and is driven by a 58 hp. G. E. motor. The fans supply air to the propulsion motor, the generators, the exciters and the switchboard. The outlets from the main motor and generators are led into a common duct which discharges to the atmosphere above the fidley top. There are also four outlets to the engine-room. Numerous dampers and deflectors provide means of adjustment to insure correct distribution of air to the various parts of the system.

The engine-room pumps were supplied by the Worthington Pump and Machinery Corporation, and the motors by the General Electric Company. The lubricating oil and circulating water pumps are connected to common motors. Three sets are used in normal service, the other set being a standby. Seven pumps are of the centrifugal type and seven are rotary, one is a plunger pump and one is steam driven.

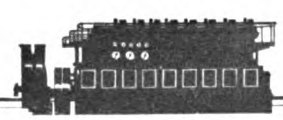
Electric current for port use—when the winches are not in operation—is supplied by a small Diesel-generator set consisting of a Fairbanks Morse two-cycle, airless-injection engine, direct connected to a 36 kw. generator. It operates at 800 r.p.m., and supplies current at 240 volts. The auxiliary power system and the lighting system, throughout the ship, operates on 230 volt direct current.

Steam for heating is supplied by a vertical fire-tube donkey-boiler which burns fuel oil through a Ray gravity feed burner. The boiler contains 400 sq. ft. of heating surface and is designed for 110 lb. pressure.

It will be realized that port fuel consumption will vary. It will be one to two tons per day higher in winter than in summer. In the daytime, when the winches are operating, it will be at the rate of five tons per day, but at night this will drop to ½ ton.

One Sepco fresh-water heater is installed in the engine-eroom. This heater is of the electric-storage type made by the Automatic Electric Heater Company, and is capable of maintaining 100 gallons of water at 160 deg. F. Another heater, of the same type and made, with a capacity of 15 gallons at 160

How the machinery arrangements admitted the new installation without major structural alterations to the engine-room space is shown by this plan view.



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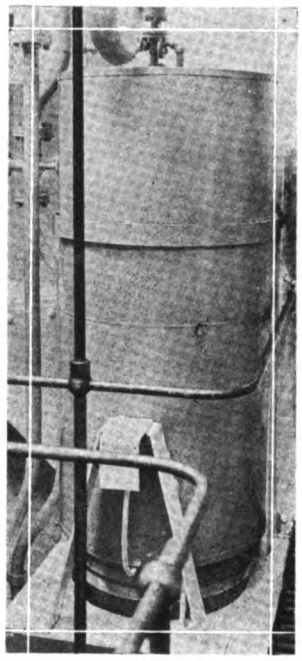
deg. F., is installed in the steering engine-room. Similar Sepco heaters in service on the first 12 Shipping Board conversions have given excellent results.

The engine-room is protected against fire by a Pyrene foam generator, while the old steam smothering lines are used in the holds.

A Tyfon signal has been fitted on the stack. Its operation requires a comparatively small volume of air and so it is particularly well suited to Diesel-electric ships which do not have the huge air storage capacity of motorships with reversible engines.

The propeller is of the four-bladed built up type with manganese bronze blades and cast steel hub. It is 21 ft., 6 in. diameter by 22 ft., 9 in. pitch.

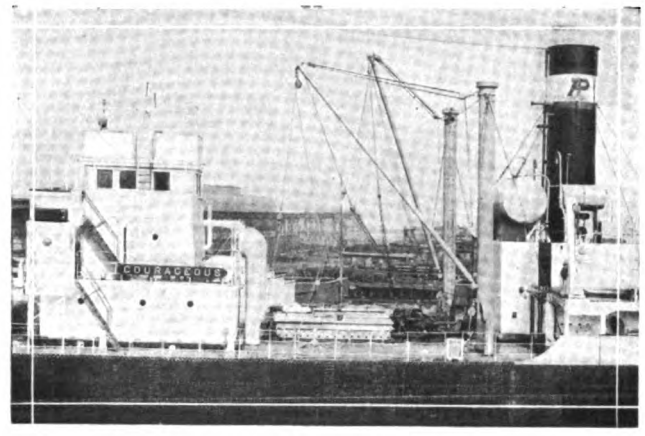


Sepco electric heater.

The propeller has been relocated, moving its center aft of its original location, and raising the shaft center to 11 ft., 3 in. above the base line at the old after perpendicular. New cast-steel stern frame, rudder and rudder stock have been fitted. The shaft tunnel was modified to suit the new line of shafting and steady bearing foundations rebuilt.

The twelve steam cargo winches, including their foundations, have been removed and replaced by twelve new Hyde electric winches, each having one drum and one gypsy head and 25 hp. 550 r.p.m. G.E. watertight motor. The steam connections, connecting-rods, crank-pins and discs, eccentrics, etc., were removed from the windlass, and it was electrified by fitting end thrust collars and a pair of bevel gears on the crankshaft, the bevel gear shaft being driven through a flexible coupling by a G. E. 70 hp. waterproof motor.

The original steering gear has been changed from steam to electric by removing the old engine and fitting a new train of gears and a 45 hp. waterproof G. E. motor. The Ward Leonard system of



The existing stack with a Tyfon signal lends a trim appearance to the midship section.

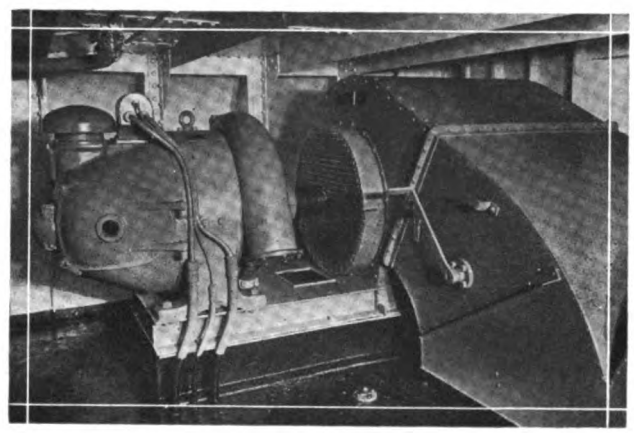
control is used. For this a General Electric motor-generator set, consisting of a 67 hp. motor and a 43 kw. generator is installed.

Part of the old pilot-house equipment has been retained, but a Sperry gryo pilot is installed. A Sperry electric telemotor is also installed with a regulation Sperry power unit aft. This operates a potentiometer rheostat through follow up links. The old Bethlehem hydraulic telemotor is connected to the same links, making it possible to operate the potentiometer rheostat through either telemotor. The change from electric to hydraulic, or vice versa, can be made instantly in the pilot-house.

There is one rudder angle indicator in the pilot-house and another aft at the emergency steering station. A Sperry gyro compass is provided complete with motor generator and repeaters.

A new three-ton, motor-driven Brunswick Kroeschell Company's ammonia refrigerating plant has been installed in place of the old steam-driven plant.

In addition to changes incidental to the conversion to Diesel-electric drive and fitting electric deck auxiliaries, the entire ship has been reconditioned and the hull lengthened 11 feet by removing the old bow forward of the forepeak bulkhead and adding a new bow, making the forepeak 11 feet longer than originally.



One of the two Sturtevant blowers installed in the upper deck house.

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Equipment List of Courageous

Name of Unit	No. of Units	Make	Power or Capacity
MAIN POWER			
Diesel engines	4	McIntosh & Seymour	1200 b.hp.
Generators	4	General Electric	800 kw.
Exciters	4	General Electric	100 kw.
Main propulsion motor	1	General Electric	4500 s.hp.
Ventilation fans (main propulsion)	2	Sturtevant	35,000 ft.f.a.min.
Switchboard (main propulsion)	4	General Electric	(Dead front)
Exhaust silencers	4	Maxim	30 in. x 90 in.
AUXILIARY POWER EQUIPMENT			
Aux. generator	1	General Electric	36 kw.
Aux. generator Diesel engine	1	Fairbanks-Morse	54 b.hp.
Power limiting device	1	General Electric	
Switchboard (exciters and aux. generators)	1	General Electric	(Open front)
Exhaust silencer	1	Maxim	10 in. x 34 in.
PUMPING EQUIPMENT			
Engine circulating pumps *	4	Worthington	400 g.p.m.
Bilge and ballast pump	1	Worthington	300 g.p.m.
Fire and sanitary pumps	2	Worthington	200 g.p.m.
Washing water pump	1	Worthington	25 g.p.m.
Portable water pump	1	Worthington	25 g.p.m.
Boiler feed pump	1	Worthington	35 g.p.m.
Fuel oil transfer pump	1	Worthington	150 g.p.m.
Lub. oil pumps †	4	Worthington	(total) 366 g.p.m.
Injector, wash-down	1	Metropolitan	525 g.p.m.
Injector, boiler feed	1	Metropolitan	260 g.p.m.
Circulating water suction strainer	2	Andale	(Twin strainers)
LUBRICATION AND FUEL			
Lub. oil coolers	3	Andale	550 g.p.m.
Lub. oil pumps	2	De Laval	240 g.p.m.
Fuel oil pumps	2	De Laval	500 g.p.m.
Lub. oil suction strainer	4	Federal	366 g.p.m.
Lub. oil discharge strainer	2	Andale	733 g.p.m.
Fuel oil suction strainer	1	Federal	150 g.p.m.
Fuel oil discharge strainer	1	Andale	150 g.p.m.
Lub. oil heater	1	Andale	300 g.p.m.
Fuel oil purifiers	2	De Laval	600 gal. per hr.
Lub. oil purifiers	2	De Laval	350 gal. per hr.
AIR EQUIPMENT			
Emergency air compressor	1	Worthington	8 cu. ft. f.a.min.
Starting air flasks	4	Nat'l Tube	16 cu. ft.
Injection air flasks	4	McIntosh & Seymour	2¼ cu. ft.
Whistle air tank	1	Federal	15 cu. ft.
DECK MACHINERY			
Steering gear motor	1	General Elec.	45 hp.
Steering gear	1	Hyde-Beth-G. E.	(Electric)
Anchor windlass ‡	1	Bethlehem-G. E.	25 hp.
Warping winch ‡	1	Bethlehem-G. E.	25 hp.
Cargo winches	12	Hyde	25 hp.
DOMESTIC WATER EQUIPMENT			
Fresh water heater	1	Sepco Electric	100 gal. @ 160 deg. F.
Fresh water heater	1	Sepco Electric	15 gal. @ 160 deg. F.

* Circulating water and lubricating oil pump combined in one unit with large motor.
† Fitted with Farrel reduction gears.

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Name of Unit	No. of Units	Make	Power or Capacity
SIGNALING DEVICES			
Radio set	1	R. C. A.	1 kw.
Radio set	1	R. C. A.	2 kw.
Telephone system	1	Magnavox	5 stations
Storage batteries for above	1	Exide	120 amp. hr.
Whistle	1	Tyfon	200 m.m.
VENTILATING SYSTEM			
Vent. fan machine shop	1	Sturtevant	1500 cu. ft. f. a. min.
Vent. fan ice machine room	1	Sturtevant	1500 cu. ft. f. a. min.
Vent. fan rheostat room	1	Sturtevant	1500 cu. ft. f. a. min.
PROPELLER & DRIVE			
Line shafts	7	Federal	4000 s.hp.
Thrust shaft	1	Federal	4000 s.hp.
Tail shaft	1	Federal	4000 s.hp.
Line shaft bearings	7	Bethlehem	(existing)
Thrust bearing	1	Kingsbury	4000 s.hp.
Stern tube	1	Federal	(new)
Propeller	1	Federal	4000 s.hp.
MAIN ENGINE EQUIPMENT			
Crankshaft	4	Erie Forge	
Lubricators	4	Manzel.	
Lubricating oil used on shop test		Standard Oil of N. Y.	
Lubricating oil used on sea trials		Texas Co.	
Shims	(All)	Laminum	
Piston rings	(All)	American Hammered	
Bearing metal		Empire	
Valve springs		Chatillon	
Gaskets		Fitzgerald	
Exhaust and Inlet valves	64	Driver Harris	
Governors	4	Massey	
Gauges		A. S. & B. & Ashcroft	
Asbestos pipe covering		Johns-Manville	
Control system		Monitor	
PILOT-HOUSE EQUIPMENT			
Main engine tachometer	4	Amer. Schaeffer & Budenberg	
Speed limit device	4	Consolidated Engine Stop	
Master Gyro Compass	1	Sperry	
Steering and bearing repeater compasses	2	Sperry	
Submarine signal system	1	Submarine Signal	
Gyro Pilot	1	Sperry Two-Unit	
Searchlight	1	General Elec.	
Helm angle indicator	1	Sperry	
Whistle control	1	Elec. Signal Control	
Telemotor (original)	1	Bethlehem	
Telemotor (new)	1	Sperry	
Sounding machine	1	Kelvin	
MISCELLANEOUS, ETC.			
Auxiliary engine lubricator	1	Madison-Kipp	
Machine shop motor	1	General Elec.	7½ hp.
Lathe grinder and drill press	1	Each (existing equip.)	Belt drive
Traveling crane trolleys	4	Wright	2 ton
Fire extinguishing engine	1		2400 gal.
Ammonia Compressor	1	Diehl-Brunswick	1 ton
Thermometers	175	Tagliabue	

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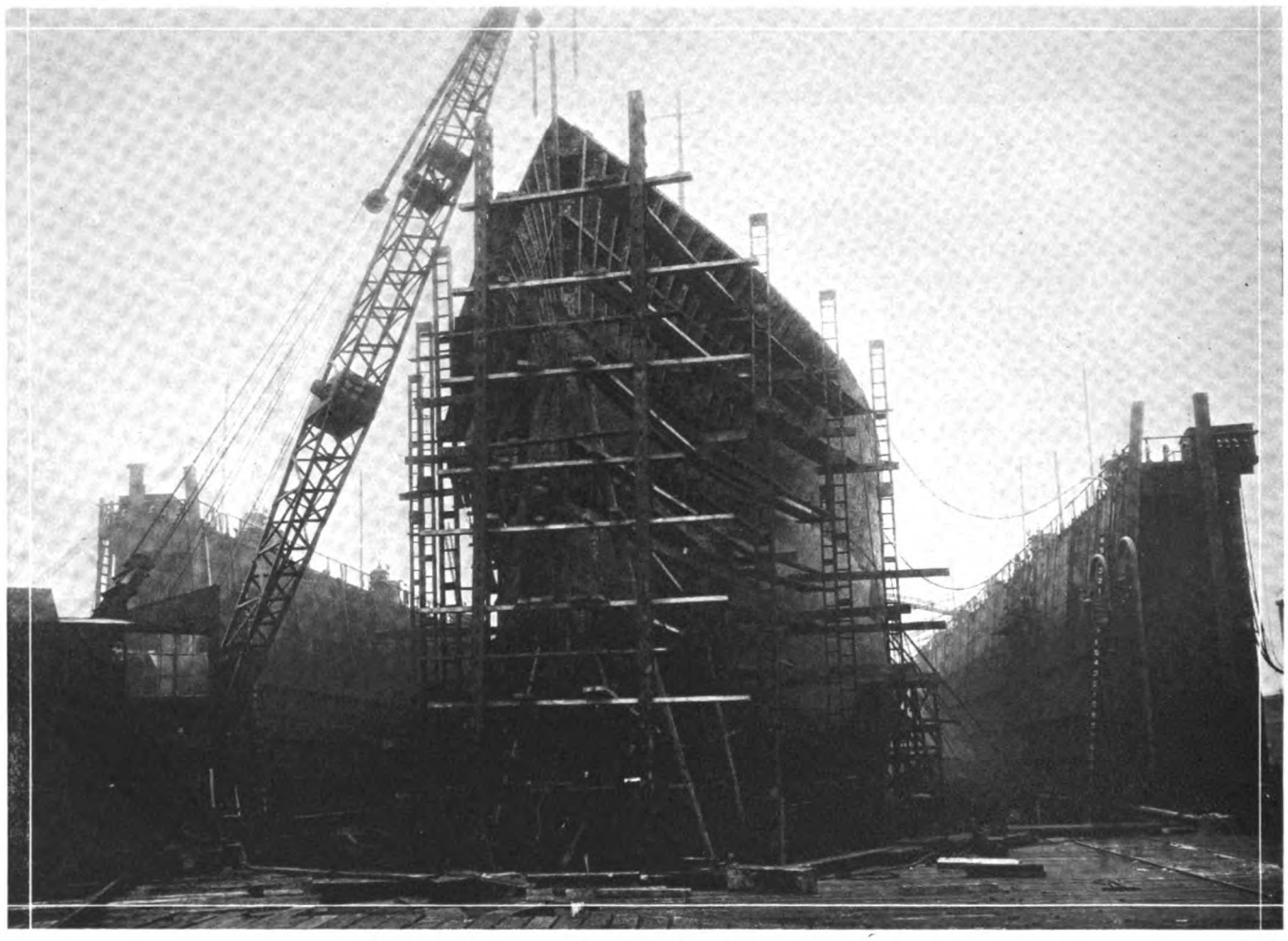
How the Work Was Cleverly Handled Under Difficult Conditions at the Federal Shipyard

Engineering Aspects of the Conversion

WITH its bid of $1,319,000 for the conversion of one vessel to Diesel-electric drive, the Federal Shipbuilding & Drydock Company, Kearny, N. J., gained the only award made to a private yard when the contracts were left for the conversion of the three steamers COURAGEOUS, DEFIANCE and TRIUMPH. The Company also made a bid of $3,747,000, for the conversion of all three vessels, but though this was the lowest firm price for the whole group, politics prevailed and the contracts for two of the vessels were placed with Navy Yards at indeterminate sums, the official estimates of which clearly indicate that the aggregate cost of the three ships will exceed the private yard's aggregate bid.

The contract with the Federal Company was signed on October 22nd, 1927, and was completed fully on October 31st, 1928, a total period of 375 days which comprised the time needed for the construction of the propelling machinery as well as the alterations to the hull. This progress is considerably more rapid than has been made in the Navy Yards, which will not complete their vessels for some time yet, and it is also much faster than the rate of progress on the other Shipping Board conversions.

All the work on COURAGEOUS is either in accord



Lines of the Courageous' bow were fined by lengthening the ship ten feet.

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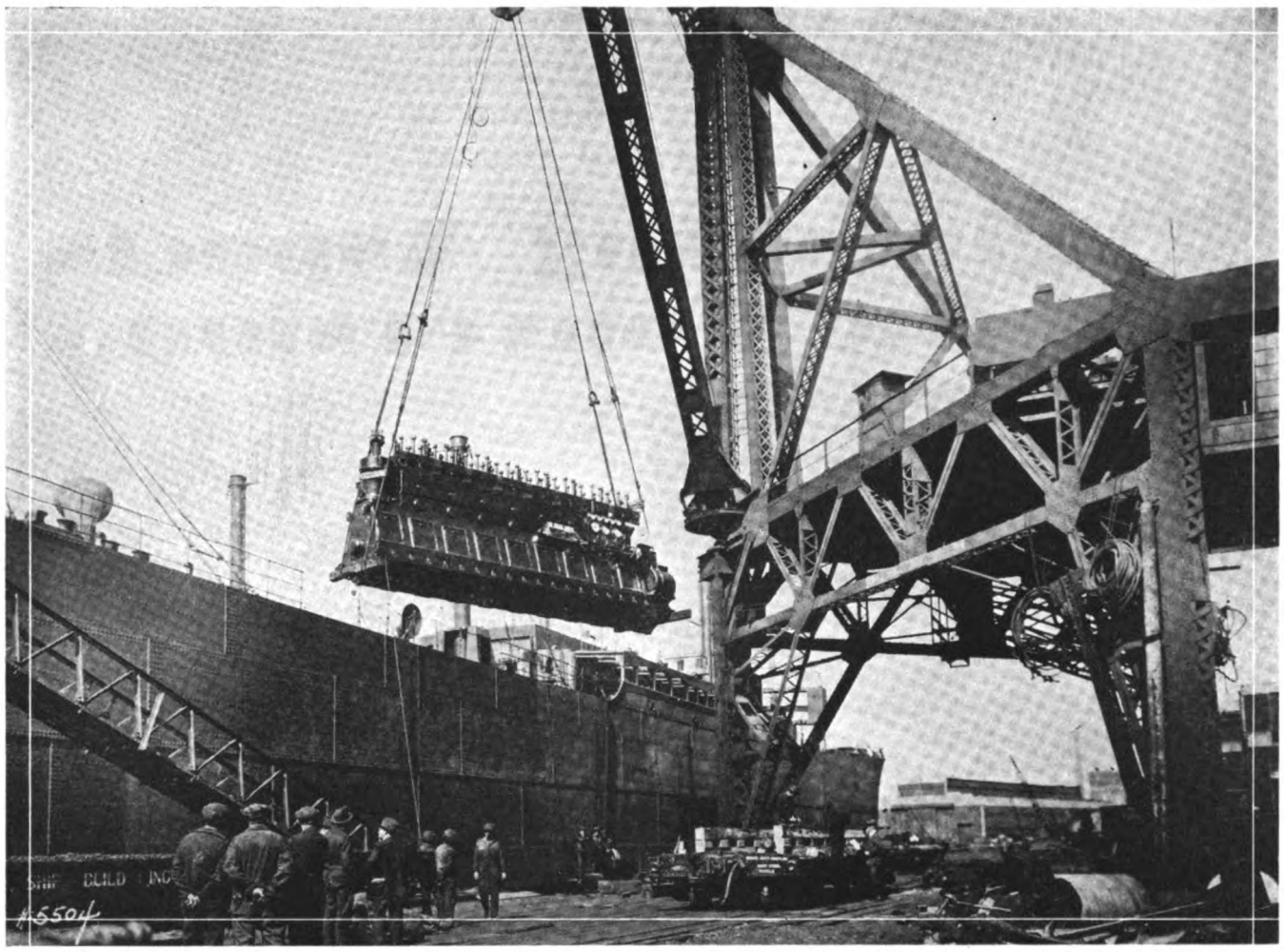
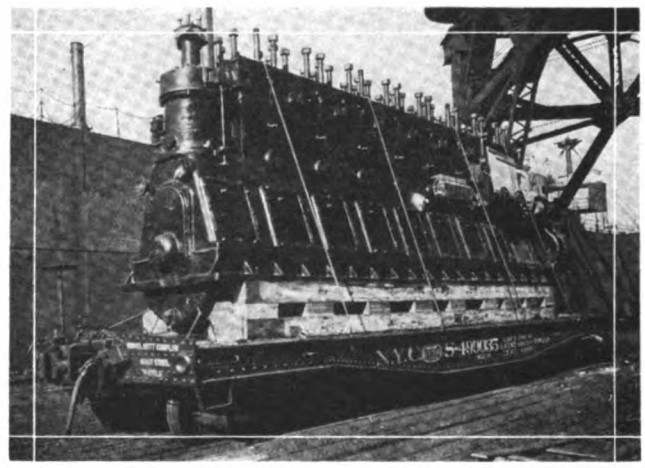


The huge dock crane at Federal shipyard enabled the four 1200 b.hp. Diesels of the Courageous to be lifted intact from the railroad flatcar into the hull

with the specifications of the naval architects or—when it departs therefrom—is approved by them. The yard is not thereby absolved from responsibility for its work, but bears the onus of satisfactory construction and installation. This responsibility has led the Federal shipyard to one notable divergence from the specifications, namely, in the machinery foundations, and its treatment of this sub-structure, incorporates an interesting feature which seems to be new and improved practice.

Instead of using entirely fabricated sections for the engine girders, the Kearny yard has topped the built-up lower part of the girders with a section of the heaviest beam rolled by the Carnegie Steel Company—a 200 lb. beam. The purpose of the beam section is to provide an uninterrupted shoulder of metal between the flange and the web, to transmit the pull of the engine holding-down bolts directly into the web through solid metal. When use is made of an entirely fabricated engine girder the pull of the holding down bolts is inevitably localized in the respectively adjacent rivets before reaching the web, and in course of time the rivets tend to become loosened by the incessantly fluctuating shear. This baneful effect can be minimized by the employment of excessively heavy angles and rivets, but complete avoidance of it in the manner indicated above is superior.



Shipping the main Diesels intact, except for valve gear and heads, simplified the work of installation.

How the engine girders have been constructed in the converted COURAGEOUS is illustrated in a sketch on page fourteen. The heavy Carnegie beam is sawn through the web. and the face of the saw cut is planed off to make a fitted butt-joint with the similarly machined face of the web belonging to the lower section. When the lapping plates

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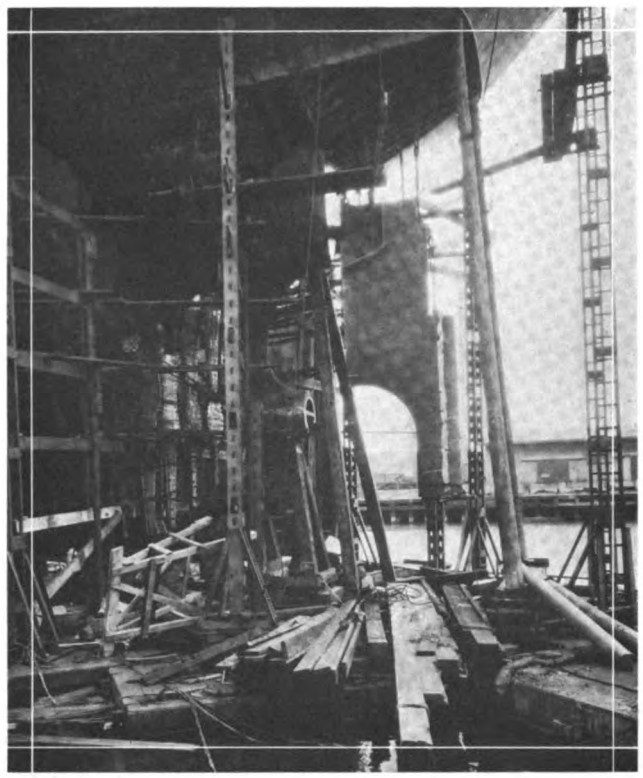
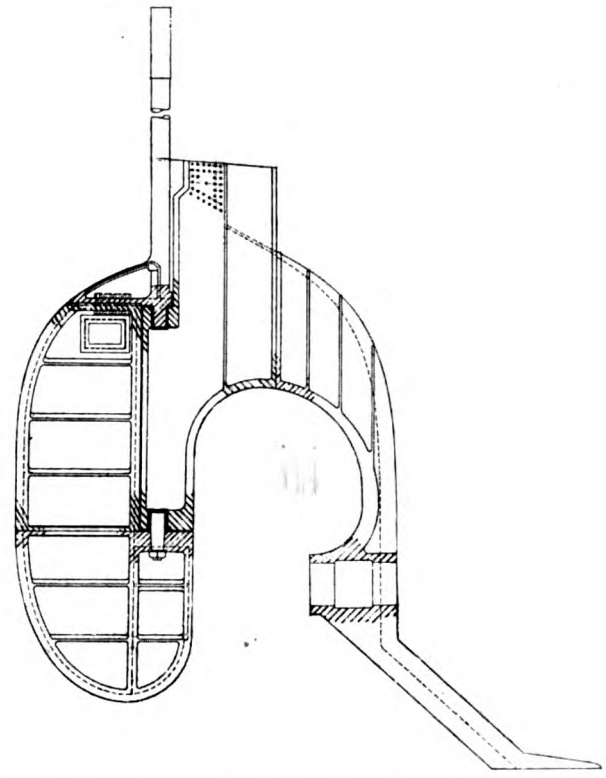


By piercing the counter the stern frame casting was lifted from below by the dock crane.

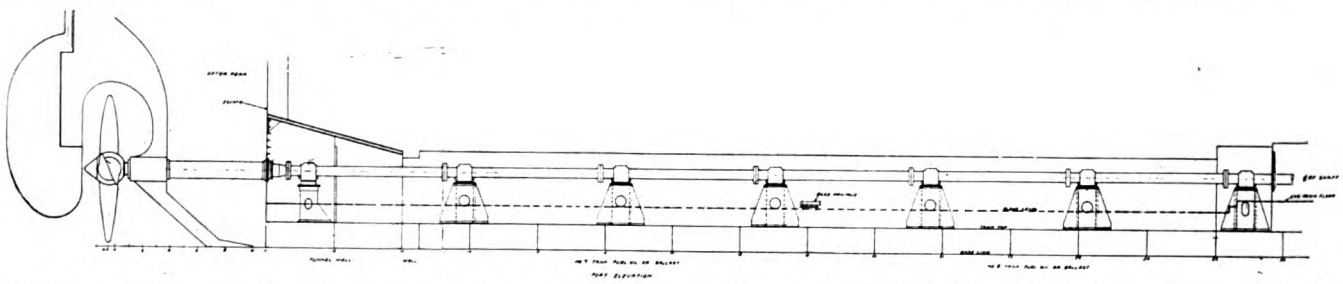


New sternframe casting and balanced rudder to favor the waterflow and propeller stream.

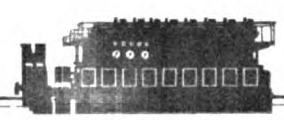
of this joint have been riveted up, the lower angles can be bedded down to the tank top and fastened, leaving the rivet holes of the bottom web to be reamed out and finished. In this arrangement there is solid connection between the engine holding-down bolts and the upper part of the web, which, being deep enough and heavy enough to resist deformation under the superimposed stresses, distributes these along its length in transmitting them to the tank top.

Appreciably more weight than the specifications called for has been built into the double-bottom under the machinery space of the COURAGEOUS, with the intent of evading the risk of vibration from any unbalanced engine forces. Heavy foundations serve the twofold purposes of damping out all vibrations and of making the natural period of vibration of the hull in way of the machinery space more remote from the possible periods of machinery vibration, thus rendering resonance more improbable. Headway is gradually being made towards the approximate prediction of the periods of vibration of machinery and hulls, but a lot more painstaking cooperation between ship-builder, engine-builder and mathematician is required to bring about that desirable end. The safe rule today deems to be to "heavy up," and the Federal company has taken a big margin for safety.

Among the construction problems that the Federal Shipbuilding & Drydock Company had to solve in the conversion of this vessel was the unusual one of shipping a heavy new stern frame without the aid of a graving dock or of a heavily-equipped floating drydock. At the Federal yard there is a 10,000 ton floating drydock and there is also a 150 ton crane, but the latter is at the fitting-out berth and not at the drydock berth. The heaviest section of the stern frame weighed about 35 tons. Study was made of such alternates as the use of heavy shear legs, a pontoon crane, etc., but choice finally fell upon the shifting of the floating dock to a berth under the big fitting-out crane.



With a larger, slower propeller and more power, the stern assumed a new form, but the shaft and tunnel remained approximately the same.



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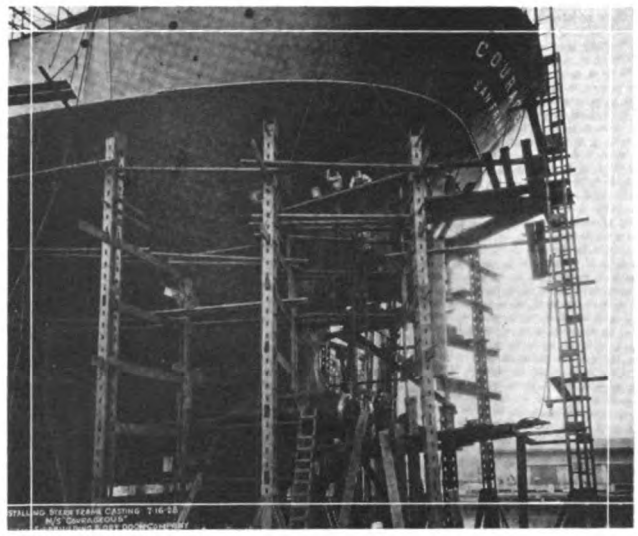
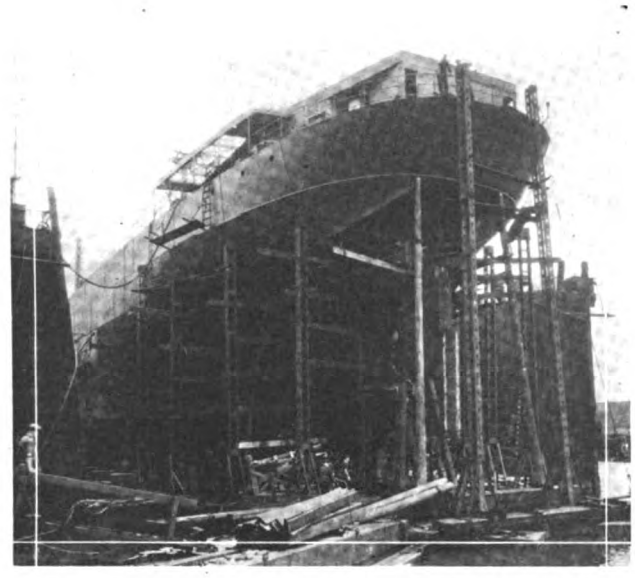
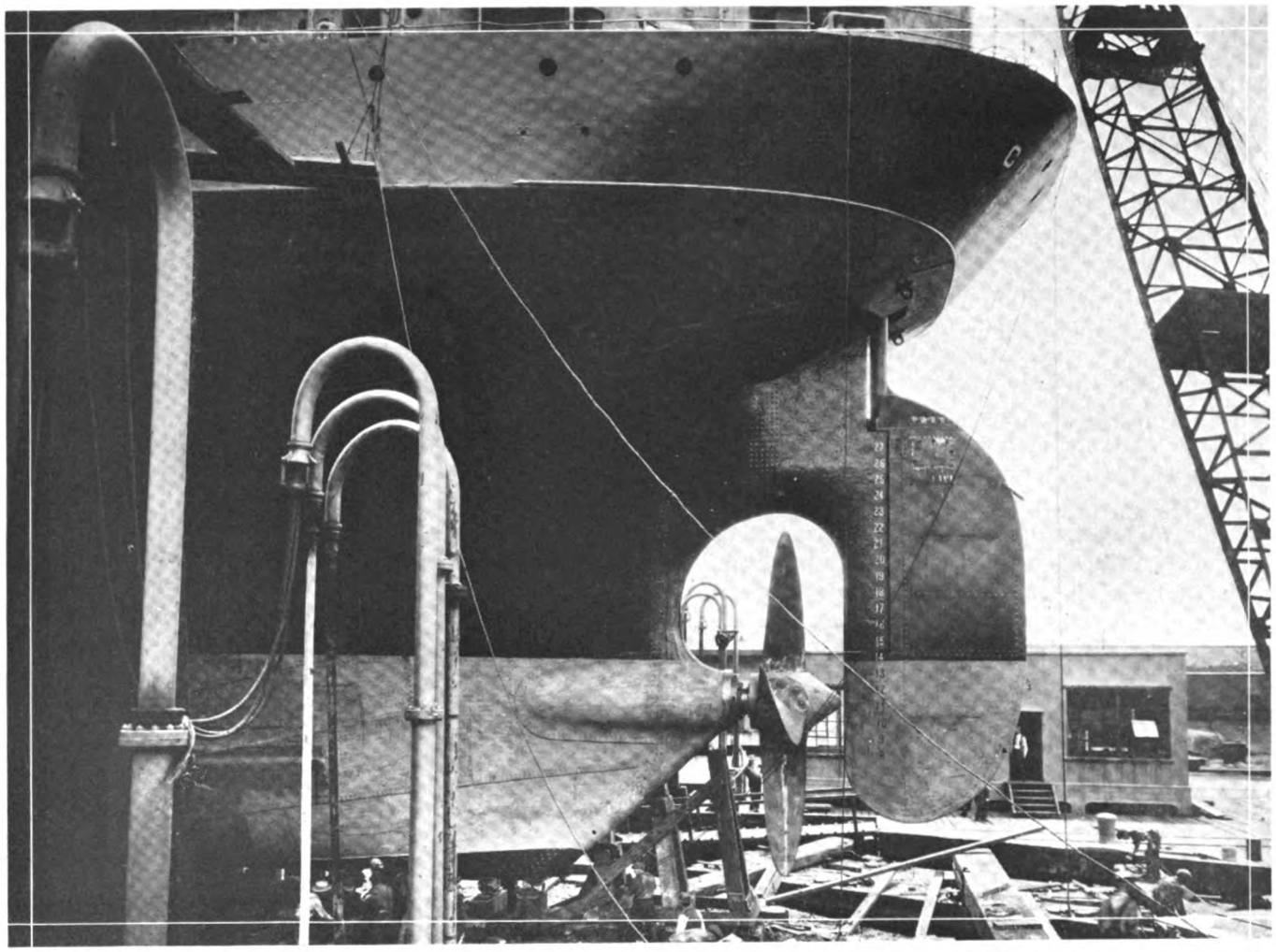


Installing the stern frame casting of the Courageous was a big job.



The stern frame was lifted into approximate position, and bolted into place when the dock fell with the tide.

The new stern frame came from the foundry in three sections to be bolted together on the job. At the bottom there is a splicing piece—see sketch herewith—which was easily handled, and the upper section is of a convenient size and weight, but the middle or trunk section posed a problem, for it is of considerable size and weighs about 35 tons and had to be swung by the land crane into true position top and bottom as the vessel rode on the floating drydock.



No evidence of the radical structural changes aft can be seen except by those familiar with the original stern of the Courageous. The finished job is a credit to American shipyard methods.

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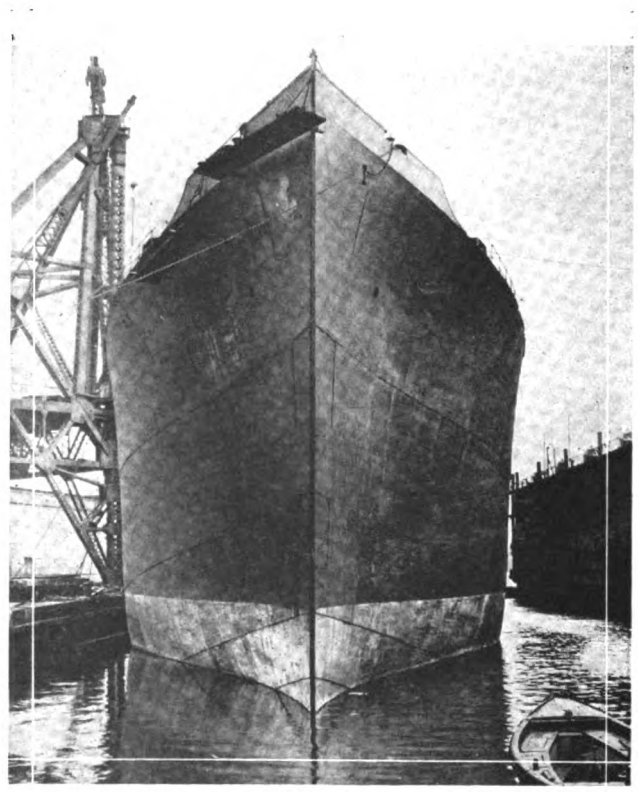
After the vessel's counter had been rigidly shored up, the old sternframe cut away and the new ribs built in as required, the floating drydock was inched into position where the crane-fall could pass down through a small aperture cut through the counter. The heavy section of the new sternframe was hooked up on the crane from the deck of the drydock below the counter and raised level with its final position, where it was landed by chain tackle and bolted home. The operation demanded precision and despatch, but it had been carefully planned down to the last detail and was completed without a hitch with the assistance of the falling tide. Wind and tide were the two elements of chance, and their influence was counteracted by careful choice of the time and occasion.

Another use made of the crane was to lift the assembled engines directly from the railroad cars and lower them to their beds in the ship. This is not unusual practice abroad, but it is uncommon here in the case of engines weighing, as these do, about 50 tons apiece when stripped. When the Federal shipyard planned this procedure it made a wide search for underslung cars and finally located one with a frame long enough and low enough to take shipment of the engine with only the cylinder heads removed. This mode of shipment and the lowering of the engines into the ship with the aid of the crane not only expedited the work and economized the cost of installation, but avoided the hazard of dirt in the bearings which is practically inescapable during the erection of machinery in a vessel and which invariably shows up in the first few centrifugings of the oil after the engine trials. The limitation to the practice of this method of installation is the loading clearance on the railroads, except in the case of engines built at shipyards when the limitation is the crane capacity.

While COURAGEOUS was at the Federal yard, numerous opportunities arose for observing the condition of the hull, because not only was the bottom minutely examined, but the tanks were cleaned out, plating was stripped for the alterations to bow and stern, etc. In the unanimous opinion of those who saw and were competent to judge, the hull was in excellent condition, belying its age in the Record because it had been laid up in sweet water. This is corroborative testimony to the wisdom of using this hull for conversion into what is to all intents and purposes a new vessel.

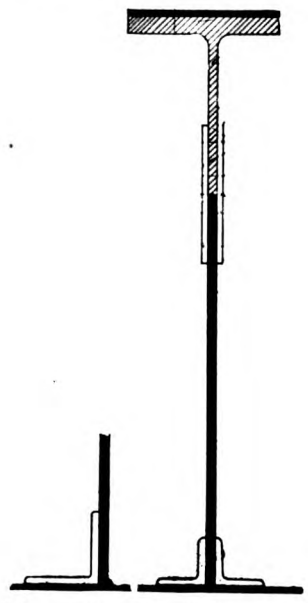
Rough estimates of members of the Federal Company's staff place the cost of building an entirely new vessel of this size and power, but to less rigid specifications, at about $1,750,000. It is true that rough estimates show a strong tendency toward growth when the time comes to fit them to a specific bid, but the small spread between this estimate and the contract price for the conversion of COURAGEOUS is due partly to the difference between private and government specifications and partly



The only outward evidence of the new bow is finer lines and a peculiar shape.

also to the need of including in the cost of conversion the gutting of the old hull, the rebuilding of bow and stern, the construction of new engine beds, the scrubbing and painting, refitting for sea, etc., which either represent part of the cost of new construction or would be altogether avoided in new building.

It is no criticism of the Shipping Board that this contrast exists. The Board's conversion orders are based upon two factors that do not rule in private operations, namely, first, it has no authority to build new tonnage but is empowered to modernize its existing vessels, and second, it has to make its specifications very exacting, like all government departments do, as a protection against corrupt bids. This estimated cost of a new vessel is quoted with all reserve as an elastic indication of the price to be paid for a Diesel-electric vessel of 10,500 tons d. w. c. and 4,000 s.hp. built in a yard where the standards of business management are high.



Use of rolled beam in engine girder.

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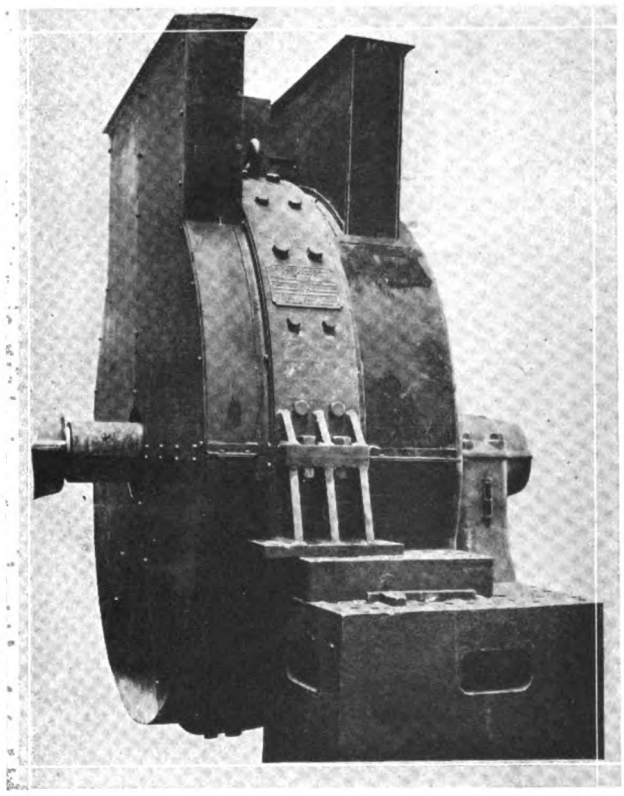
STORY of the Electrical Machinery of the U. S. S. B. Freighter Courageous

Electrical Propulsion and Auxiliary Power

H. Q. Griffith of the Direct-Current Engineering Dept., General Electric Co. Discusses the Development and Construction Carried Out at Schenectady

NOT until the Philadelphia Centennial Exhibition of 1876 was the value of a dynamo-electric machine as a motor fully recognized. Up to that time the designer's chief problem was generator operation. Today the two Gramme dynamos, formerly used to exemplify generator and motor dual characteristics, would be considered of crude design. This event of fifty-two years ago, however, may be considered as the beginning of the present "Electric Propulsion Era." With broadening of the field of service came advancement in design.

Major developments of direct-current machines for propulsion duty, nevertheless, have taken place during the last decade. In 1919 the General Electric Company received its first order for Diesel-electric propulsion equipment, to be used on the Gloucester beam trawler MARINER,—a 400 horsepower, 160 r.p.m. unit. Had anyone at that time proposed a 4000 horsepower, 60 r.p.m., direct-current motor for similar duty, no doubt he would have been classified as a dreamer. But great strides made since have made this practical.



One of the Courageous' four main generators, showing ventilating enclosure.

The flexibility of the well-built direct-current motor, which is probably not equalled by any other device producing power, has been the main attributing factor to its success. Variation in speed, variation in load under any given speed, ease in change of direction of rotation, and even the efficiency factor, leave practically nothing to be desired either for cruising or for maneuvering. Therefore, the dreamer of only ten years ago now sees his visions matured to reality.

The main propulsion equipment of the COURAGEOUS now forms the largest and most powerful Diesel-electric type in service. It consists of four 800 k.w., 250 r.p.m., 375 volt main generators furnishing power to a 4000 s.hp. 60 r.p.m., 1500 volt, double-unit propulsion motor; and four 100 k.w., 250 r.p.m., 240 volt overhung generators, for auxiliary power and excitation. In general, what may be said of the design of one of these units may be said of the three others, and in this discussion only a few points of general interest concerning the design and construction of the G. E. motor will be reviewed.

This 4000 s.hp. motor consists of two separate 2000 s.hp., 750 volt motors with both armatures pressed on and keyed to a common shaft, and electrically connected in series, forming the equivalent of a single-unit, 4000 s.hp., 1500 volt motor.

The magnet frames are made from steel slabs, rolled while hot into semi-circles of a prescribed radius; with short slabs welded in place for joining the two halves; and still other short slabs welded on for feet. Thinner slabs are welded vertically between the feet and joining pieces for additional strength and re-inforcement. The use of rolled steel

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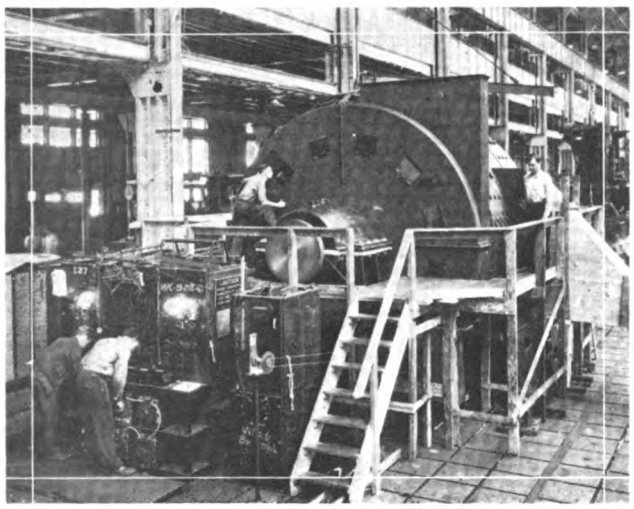
for magnet frames facilitates a reduction in weight over the cast steel frame, for a given amount of field copper—a most valuable consideration on shipboard. Furthermore, with this construction, the designer is assured of uniform material and is therefore able to make more dependable calculations. Certainly there is no single development in direct-current design during the past decade which carries with it so many advantages, without a single disadvantage, as does the rolled steel magnet frame.

The shunt field is wound on insulated sheet metal spool bodies, of rectangular insulated wire. The completed coil is treated by a vacuum process that exterminates all air pockets. Air pockets in a field coil, especially on sea duty, are almost certain to accumulate moisture and produce a breakdown. Another advantage of solidified coils is uniformity in heating.

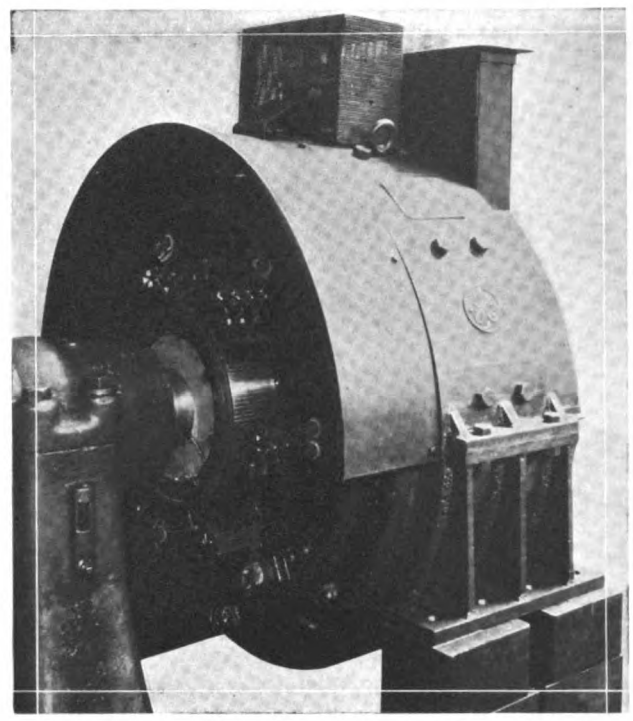
Any movement of insulated parts from vibration will of course in time cause deterioration of the insulating materials. In order to avoid this on the commutating fields of these machines the coils are wound of bar copper, thoroughly enamelled for insulation between turns, formed in a hydraulic press and rigidly clamped in position on the pole pieces with brass clamps. The first and last turns of the coils are insulated for creepage, and the coils are wound on insulated pole-pieces. After completion the coils with their pole-pieces are thoroughly filled with varnish to avoid damage from salt atmosphere.

The armature coils are form-wound and insulated with mica tape throughout the entire length of the coil. The slot portion carries a horn-fibre slot armor and is moulded to exact size. The coils are held in the slots with cross-grain maple wedges, and the end windings are firmly held by steel bands.

The commutators are made with every possible effort toward perfection. Special oil-proofing methods are incorporated in their construction. The completed commutators are baked at a high temperature, after which the clamping bolts are carefully checked to make sure no loose bars will develop in operation.



Testing the Courageous' General Electric 4000 *s.hp. propelling motor.*



Careful protection has been given to the brushes and armature on the G. E. exciters.

The bearings are made of the pedestal supported, ball-seat, self-aligning, disc-and-scraper type. The bearing housings are so designed as to prevent oil from splashing out as a result of the roll and the pitch of the ship when on rough seas. In this type of bearing the disc, which serves as an oil pump, is in the center of the bearing and is pressed on a shoulder on the shaft. The scraper, which is a U-shaped brass plate, fits over the disc and is held in place by guide slots in the upper half of the bearing. With this type of lubricator positive lubrication is assured for all conditions of operation.

The ventilation for the entire propulsion equipment is from a separate Sturtevant blower. In this way fresh air from the upper deck of the boat is furnished to all machines. For the motor and the main generators both inlets and outlets for air are carried to the upper deck. The air through the auxiliary generators is used to ventilate the engine room. Each machine thus is furnished with fresh, clean air. This promotes cleanliness of the machines and lengthens the life of the equipment.

Factors of safety used in the mechanical design of this equipment, as well as the electrical design constants, are very liberal. Throughout its design the main goals have been performance and service.

During the factory test the entire equipment demonstrated its ability to do the work expected of it. The combination of generator and motor efficiency proved to be 88.57 per cent, which was slightly above the calculated value. Commutation was all that could be asked of any design, and each machine met heating guarantees by a safe margin.

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HANDLING is Carried Out From Either Pilot-House or From Engine-Room of Diesel-Electric Ship Courageous

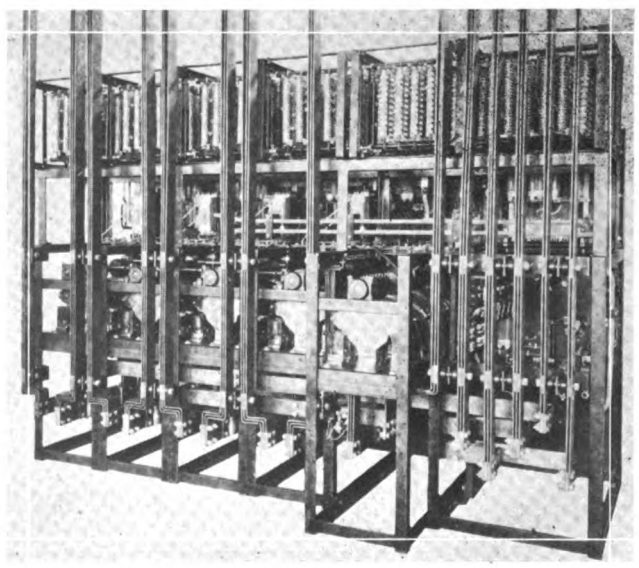
Controlling the Propulsion Equipment

Story by R. O. Dunham, Marine and Aircraft Engineering Dept., General Electric Company

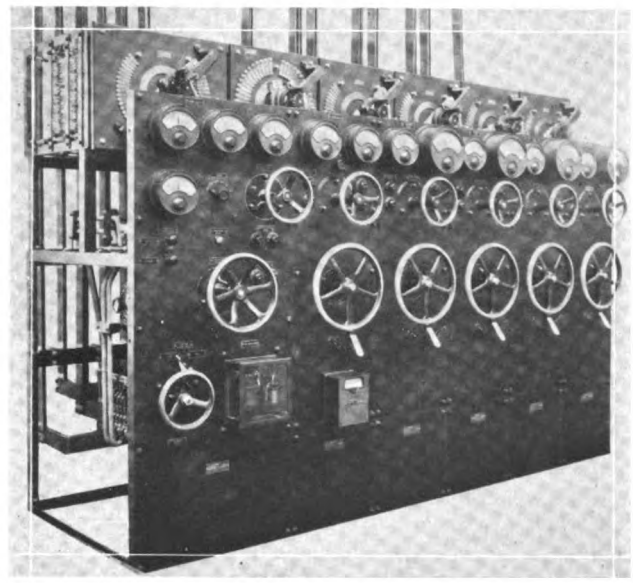
POWER applied to the electro propulsion motor of the COURAGEOUS may be controlled from either engine-room or pilot-house station to drive the ship at desired speeds, ahead or astern. Propulsion control equipment consists of two distinct groups of parts, that located in the engine-room and that located in and below the pilot-house.

The engine-room equipment consists of a group of dead-front panels—four generator panels, a motor panel and a control panel—together with the engine-room controlling rheostat and the regulator motor-generator set. The pilot-house equipment is composed of a controller for operating the controlling rheostat located near the pilot-house, the rheostat itself and an instrument panel.

The four generator panels are all alike. Each is made up of an angle-iron framework faced by steel plates on which are mounted the electric instruments and the levers and hand wheels for operating the dead-front type switches.



Back of the Courageous' well-built switchboard



General Electric dead-front switchboard of the Courageous.

A handwheel is located on the front of each generator panel for operating the generator field rheostat mounted within and supported by the angle iron framework. Each generator panel is provided with two instruments, an engine horsepower meter and a main generator voltmeter.

The generator field regulating rheostat is operated from the front of the panel. When the generator is connected in the propulsion circuit and when the controlling rheostat is in a full-speed position, this rheostat is used to adjust the generator voltage to approximately 375 volts. When the generator is used for auxiliary power this rheostat is used to adjust the voltage to 240 volts.

The generator switch consists of two parts, a drum switch for handling the field circuits and a main switch for controlling the armature circuits. Both parts are operated by the 16-in. hand wheel on the front of the panel. The control switch interlocked with the main switch is operated by the lever at the right and extending below the hand wheel.

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There are three operating positions for both the main and control switches; viz, "Propulsion," "Off" and "Auxiliary Power." Interlocking is so arranged that the main switch cannot be operated unless the control switch is in the "Off" position. The control switch energizes the generator field contactor in the "propulsion" and "auxiliary" power positions. In the "Off" position the field is disconnected from the excitation bus and connects across the generator armature, killing the voltage.

The main switch is a 3000-ampere, three-position unit. The hand wheel on the front of the panel rotates a shaft to which are keyed "textolite" pinions. These pinions mesh with teeth in the sector shaped copper blades. In the "Propulsion" position the generator is connected into the propulsion circuit in series with any other generator whose main switch is in the "Propulsion" position, and in series with one or both halves of the double-unit propelling motor. In the "Off" position the generator armature is disconnected from all circuits and the propulsion circuit completed. In the "Auxiliary Power" position the generator is connected across the auxiliary power bus, and the propulsion circuit is completed so that the motor can be driven from power generated by the other generators. Mechanical interlocking between the switches is such that only one generator can be connected to the auxiliary power bus at a time.

When the field contactor is closed, the drum switch part of the generator switch connects the generator field directly to the excitation bus in the auxiliary power position. In the "Propulsion" position of the switch, it connects to the controlling rheostat, also through the field contactor.

Similar construction to the generator panel is to be found in the motor panel. The motor switch has the same type of drum switch and main switch, and has three operating positions, "Motor 1," "Both motors" and "Motor 2." The control switch and the motor switch are interlocked, so that the motor switch cannot be operated unless the control switch is in the "Off" position.

Two instruments are located on the motor panel, the motor-voltmeter and the motor-field ammeter. The voltmeter is connected through a voltmeter switch across either of the two motor armatures. Mounted on the lower part of the motor panel is the watt-hour meter for recording the power delivered to the propelling motor. The motor field rheostat operated from the motor panel provides for a possible 15 per cent adjustment in the current of the two fields in parallel.

On the control panel there are three instruments, the line ammeter, propeller-speed indicator and ground-detector voltmeter with six-position ground-detector switch. The motor field rheostat operated from the control panel is connected into the field circuit of Motor No. 1. By operation of this rheostat, the field of Motor No. 1 is changed to adjust the load on the generators in the circuit.

The switch for transferring the generator field circuits from the engine room controlling rheostats to the rheostat located near the pilot house is mounted on the common panel. It is of the two-position, six-circuit type. The control switch (which must be in the "Off" position before the transfer switch can be thrown) controls the operation of the excitation contactor. In the "Off" position of the switch, the excitation contactor is tripped. In this way the possibility of opening the generator field circuits on the transfer switch is prevented.

The excitation contactor,—a double-pole, 300-ampere unit of the mechanically latched-in type with discharge contacts,—is located within the frame work of the control panel. Also mounted on the control panel is the hand wheel and operating mechanism for the engine-room controlling rheostat. Speed and direction of rotation of the propelling motor are controlled from this point through regulation of the current through the generator fields. The rheostat is of the potentiometer type and provides for gradual changes in generators' field currents,—and therefore in motor speeds,—from zero to full speed. Rotation of the rheostat hand wheel from the "Off" position to the right causes ahead rotation of the motor, and to the left causes astern rotation of the motor.

In the pilot-house there are mounted a small indirectly illuminated panel with line ammeter and propeller speed indicator, and a controller with hand wheel. Rotation of this hand wheel through gearing operates a controlling rheostat of the same type as that located in the engine-room. Gearing between the controller and the rheostat is designed to prevent overloading of the engine equipment.

A motor-generator set forms part of the COURAGEOUS propelling control equipment. Its operation is controlled by a regulator on the control panel. This regulator tends to hold a constant load on the engines in use. The setting of the regulator is adjusted directly by the operation of the motor field rheostat on the control panel, which is used to weaken the field of Motor No. 1 to load fully the generators connected into the propulsion circuit. The generator of this motor-generator set is connected in series with the bus, supplying excitation to the generators used for propulsion. This tends to buck down the excitation voltage whenever the kilowatt setting for which the regulator is adjusted is exceeded. In this way the operator in the pilot-house or engine-room can move his hand wheel from "full ahead" to "full astern" as rapidly as he wishes. His mind will be relieved because he will have the knowledge that the full output of the engine equipment will be applied to the propellor at will, but without danger of excessive overloading.

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Taking Advantage of Modern Production Methods Adds to the Overall Economy of American Ship Operation

Diesel-Electric Drive and its Application to Ship Conversion

Written by E. F. Clark of the Westinghouse Electric & Manufacturing Company

DIESEL-electric drive, from an economic standpoint, is advantageous as compared to direct Diesel drive for ocean-going cargo ships. This is a statement which, on the face of it to the majority of marine engineers, would not seem to be correct. The Shipping Board's decision to install it in several of their large cargo ships has accordingly been looked at somewhat askance by many.

For the conversion to Diesel drive of existing cargo steamships, and for tankers carrying light oil and gasoline, a number of carefully prepared comparative estimates have been made. These estimates clearly show a material saving in first cost, weight of machinery, and space required for the Diesel-electric drive installation as compared to direct Diesel drive of the same power. Of these comparative estimates and studies with which the writer is familiar, several were made by Westinghouse engineers in cooperation with a disinterested naval architect or a shipyard with experience in Diesel conversions on large ships, several were prepared independently by Diesel engine manufacturers and the others are comparative estimates made by shipyard engineers. Standard engines of conservative designs and ratings were utilized in the figures for Diesel-electric drive and compared with the double-acting as well as single-acting types available for direct drive. The comparisons in each case were based upon the same propeller speeds, the range of these being from 90 to 110 r.p.m.

These separately made studies coincide remarkably in the results indicated, hence, the actual figures taken from the latest study made by the Westinghouse engineers in cooperation with one of the shipyards may be taken as representative. This comparative study was based upon 3300 s.hp. at 90 r.p.m.

The total cost of all machinery items and of installation, foundations and structural changes of the vessel required in making the conversions was $37,700 in favor of the Diesel-electric. This is slightly over 10 per cent of the total cost of propelling machinery and main auxiliaries. The weight of machinery was 320,000 pounds, or 143 long tons less for Diesel electric.

Fuel oil cost, figured when Diesel fuel was $2.05 per barrel, and the vessel in the Australian trade, assuming that theoretically the Diesel-electric will require 15 per cent more fuel, would be $7770 greater per year. As a matter of fact, actual experience of operating companies with comparable direct and electric drive Diesel ships has shown, in a number of cases, lower fuel oil consumption for the electric drive. In no case has the difference favored direct drive more than a small percentage.

The lubricating oil cost favors direct drive by $750 per year.

The income from cargo is increased by slightly over $20,000 per year for the Diesel-electric ship. This is based upon average rates in the Australian trade and assuming that only one-half of the increased deadweight and cubic cargo-carrying space is used. A summary of all items entering into the cost of operation and revenue produced shows an apparent additional yearly earning capacity of $25,400 for the Diesel-electric ship.

Several of these comparative studies were presented to the Shipping Board in order to bring forward the relative merits of electric versus direct drive for vessels then being considered. For the conversions in question the Board's naval architects made their own studies and comparative estimates before deciding on which type of drive was to be recommended.

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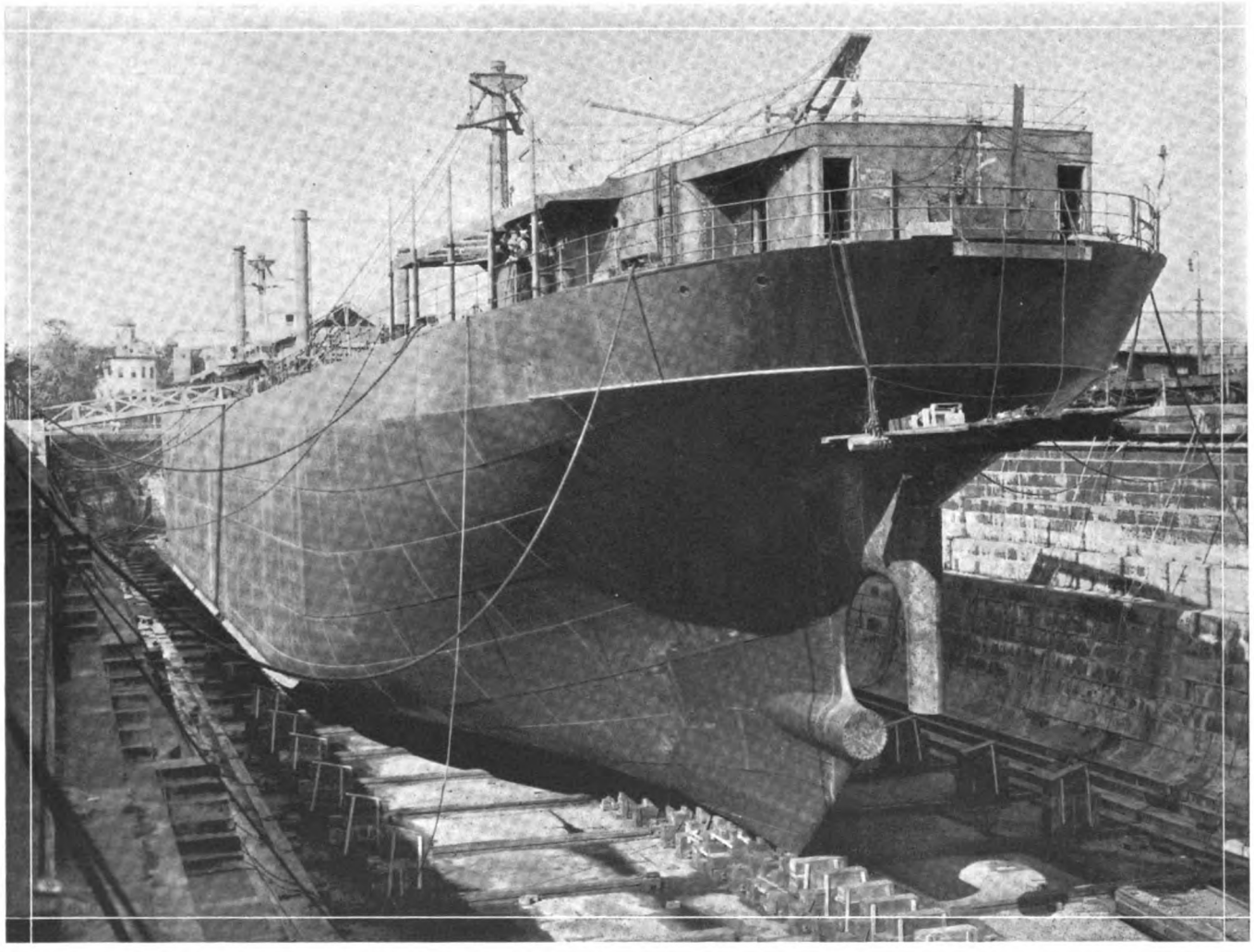
Entirely aside from the fact that the 60 r.p.m. propeller under consideration would be especially advantageous to the Diesel-electric drive, the accuracy of the other estimates and studies made of this question was amply borne out by this recommendation. It is obvious, therefore, that the Board was treading upon solid ground when it decided upon the new type of drive for the TRIUMPH, DEFIANCE and COURAGEOUS.

Incidentally, it is interesting to note at this time that when the first phase of the Shipping Board's Diesel conversion program was under consideration, one member of the committee appointed to recommend what types of engines should be used, made a detailed comparative study of Diesel-electric vs. both single and double acting types of direct drive engines. This study showed that the Diesel-electric drive was economically preferable; it was recommended, and data supporting this was handed on to the Board.

At about this same time, an article written, by Messrs. W. E. Thau and H. C. Coleman of the Westinghouse Marine Engineering Department, appeared in the MOTORSHIP Conversion Supplement. It presented a very carefully prepared comparative study of Diesel-electric and direct drive for cargo ship conversions and showed wherein the former was advantageous.

In the four years that have passed since the foregoing incidents, there have been much greater developments made in this country with respect to reductions in cost, weight, and space of Diesel engines adapted to electric drive than has been the case with direct drive engines suitable for large cargo ship propulsion. In this same space of time electric drive installations have continued to forge ahead in number. They have proved themselves economically advantageous for ship types and services considered by many marine engineers to be outside the realm of electric drive at that time.

Continued advances are being made in the field of relatively high speed, light weight Diesels of standardized sizes suitable for electric drive. On the other hand, the possibility of much further reducing the cost, weight and space requirements of slow speed, direct drive engines seems remote. The unsuitability of these latter to American production methods is another factor to be taken into account. It is, therefore, only a logical prediction that the new American Diesel-driven cargo ships of the near future, just as the converted steamship of today, will employ electric drive.



The extent of alterations to the stern is shown in this view of the Defiance taken in the graving dock at the Boston Navy Yard.

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WESTINGHOUSE Equipment of the Two Sister Ships to Courageous is Enclosed and Pressure Ventilated

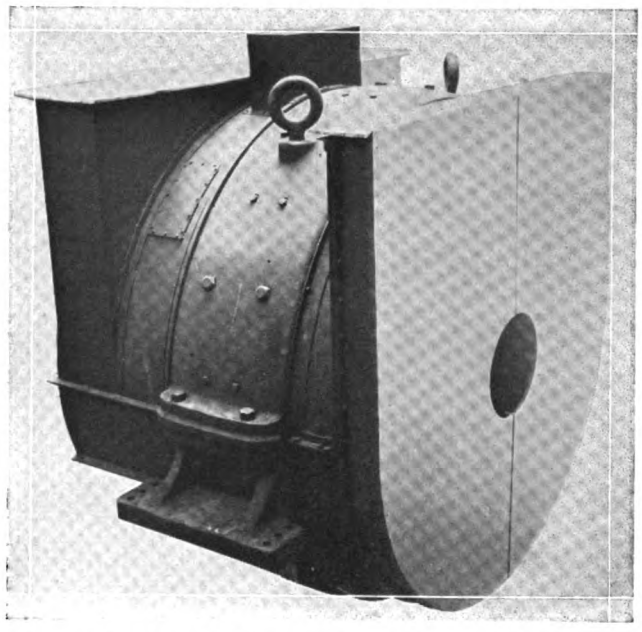
Story by H. L. MacCarter, of the Transportation Division Westinghouse Electric and Manufacturing Company

Electrical Power of the Defiance and Triumph

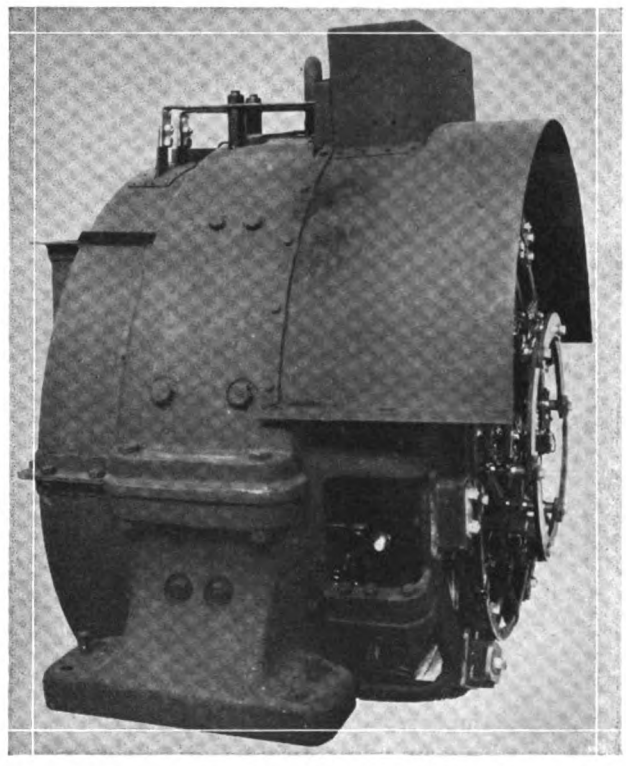
THE two sister conversions to the COURAGEOUS are not sufficiently close to the completion stage to be illustrated in this Supplement. The work on the DEFIANCE and TRIUMPH is being carried out at the Norfolk and Boston Navy Yards respectively, whose contract time is longer than that of the private yard. But the electrical machinery has been finished by the Westinghouse Electric & Manufacturing Company.

The installations arrangement includes four main generating-units for each vessel, every unit consisting of a McIntosh & Seymour Diesel engine directly connected to a Westinghouse 800 kw. D. C. generator and a 100 kw. D. C. exciter. Each main generator is a 375 volt, 40°C., 250 rpm. machine, enclosed and duct ventilated. The exciters are 240 volt, 40°C., 250 r.p.m. machines, also enclosed and duct ventilated. Connected in series, the main generators supply power for one 4000 s.hp. double armature, 750 volts per armature, 60 r.p.m. propelling motor. This also is enclosed and ventilated. The four exciters installed per ship furnish excitation for the main generators, the main propulsion motor and power for the electrically driven auxiliaries. The variable voltage type of control is used, with control arranged for pilot-house or engine-room, a unit control pedestal being installed on the bridge easily accessible to the pilot.

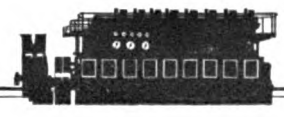
For the DEFIANCE and TRIUMPH, Westinghouse also furnished the electrical equipment for the deck auxiliary machinery. On each vessel this comprises twelve electrically-driven 25 hp. cargo winches, one 25 hp. electrically-driven warping winch, one 65 hp. electrically-driven anchor windlass and one 45 hp. electrically-driven steering gear. Motors, brakes and master switches of the cargo winches and the warping winch are waterproof, the motors being 230 volt, 520 r.p.m. machines. Controls and resistors of the deck winches and warping winch, being in special steel boxes, are not exposed and therefore have not been made waterproof. The motor, brake and control of the anchor windlass are waterproof. The motor of the steering gear is a 230 volt, 600 r.p.m. machine of the open type.



One of the Triumph's four main generators, showing ventilating enclosure



Armature and brushes are well protected on the Westinghouse exciters.



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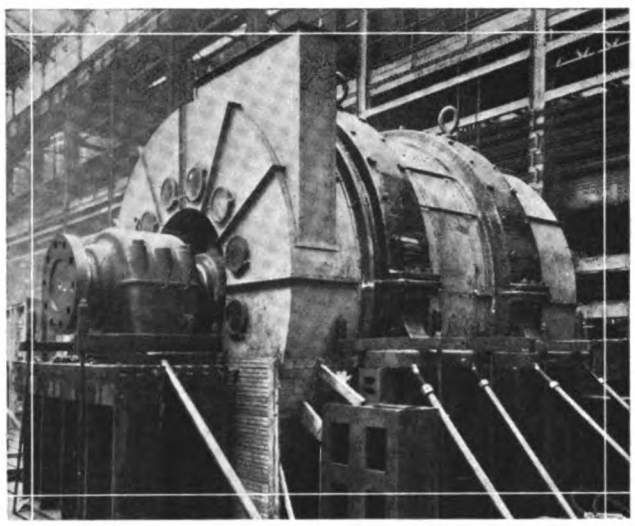
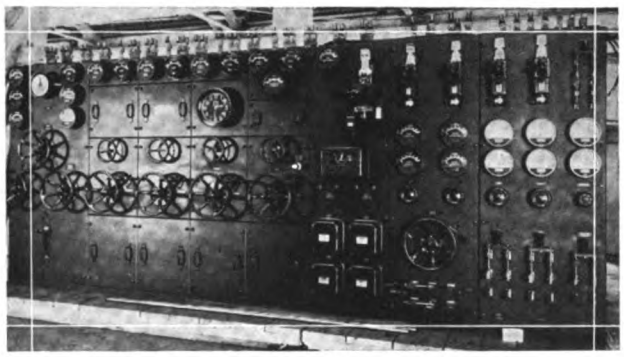


Westinghouse 4000 *s.hp., 60 r.p.m. motor of the Defiance.*

Under-deck Auxiliary Machinery

The under-deck auxiliary machinery, which is electrically driven, comprises the following apparatus all furnished by Westinghouse:



Modern in every detail is the Westinghouse dead-front main switchboard of the Defiance.

Two main blowers each driven by a 71 to 30 hp., drip-proof self-ventilated motor. These supply the entire ventilation for the propulsion motor, four main generators, four exciters and 10,000 C. F. M. of air for engine-room ventilation.

Two fire and sanitary pumps, each driven by a 11-25 hp. variable speed waterproof motor.

Two bilge and ballast pumps each driven by a 6-8 hp. variable speed waterproof motor.

One fuel-oil transfer pump, driven by a 5½-7½ hp. waterproof motor.

One ice-machine motor of 5-7½ hp. of the drip-proof variable speed semi-enclosed, self-ventilated type.

Four lubricating oil and circulating-water pumps driven by variable speed waterproof motors, which range from 42 to 50 hp. each.

One drinking-water pump driven by a 1½ hp. water-proof motor.

One fresh-water pump driven by a 2 hp. waterproof motor.

One machine-shop blower driven by a ½ hp. totally enclosed motor.

One ice machine room blower driven by a ¾ hp. totally enclosed motor.

One machine-shop motor driven by a 5-7½ hp. drip-proof semi-enclosed self-ventilated motor.

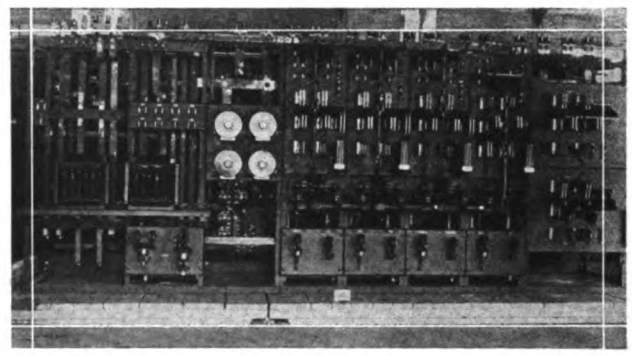
Thirty-three bracket fans with 12 in. blades.

Auxiliary Generator

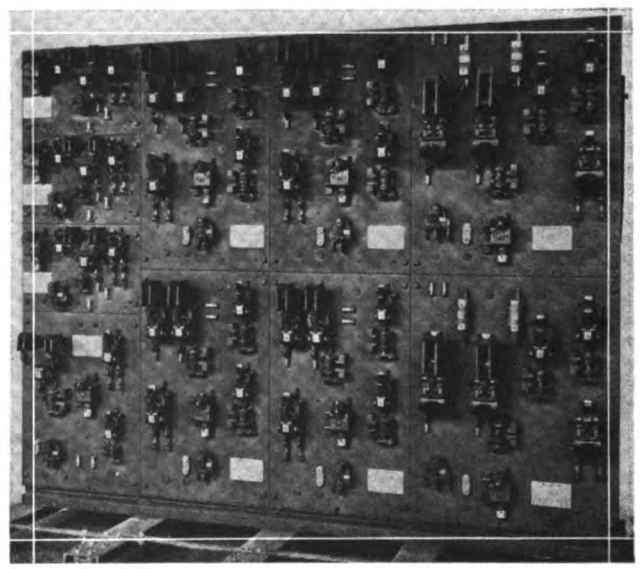
There is one auxiliary Fairbanks, Morse-Westinghouse Diesel generator unit of 36 kw. at 250 volts capacity for use in port when the main generating units are shut down. This generator is directly connected to the engine and is driven at 450 r.p.m.

Switchboards

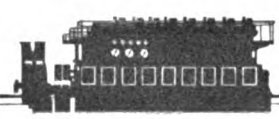
There are two switchboards in the engine room, the propulsion board, which is of the dead front type, and the auxiliary board which is fed by the exciter bus and is live front. For the auxiliary motors there are also two control group panels. They are located in the engine room, and adjacent to the motor driven pumps and contain the controls for ten of the engine-room auxiliaries.



Back of Westinghouse dead-front main switchboard



Showing convenient arrangement of auxiliary control panels of the Defiance.



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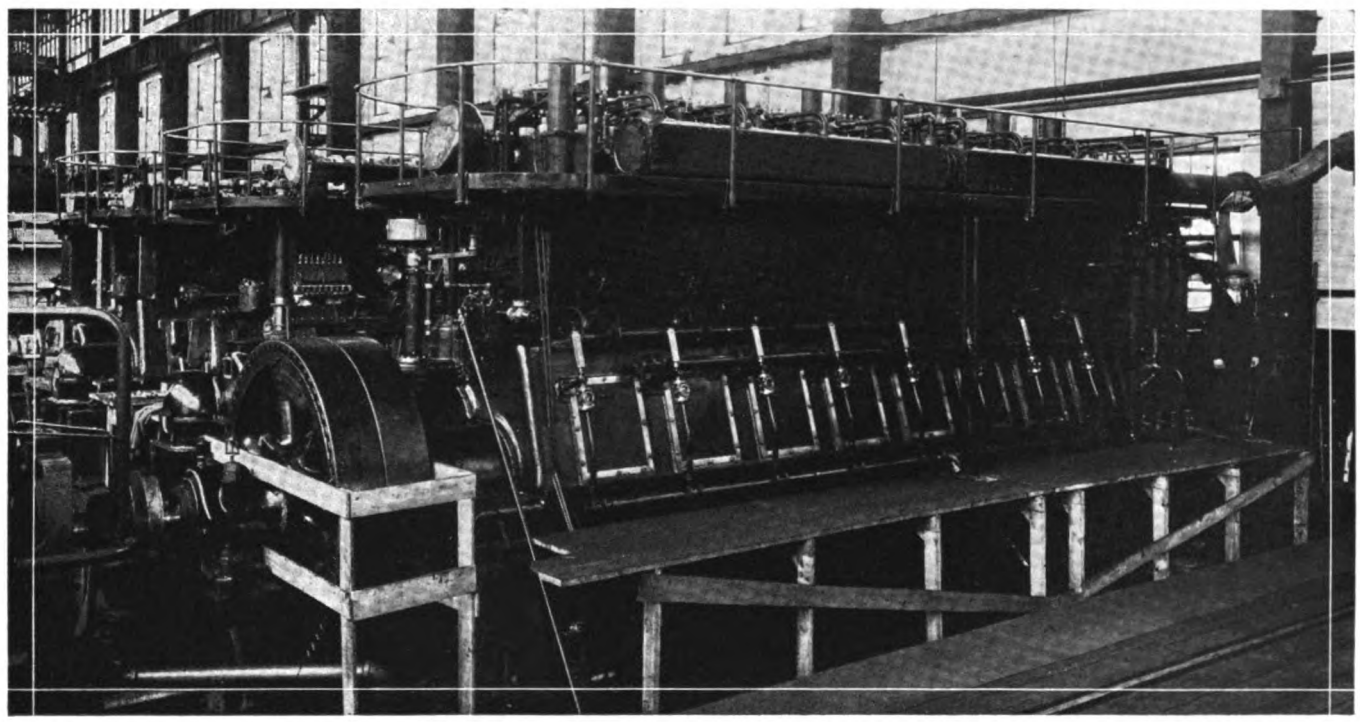
Engines of the Courageous and Sister Ships

TWELVE 4-cycle McIntosh & Seymour Diesels Power The Three Vessels

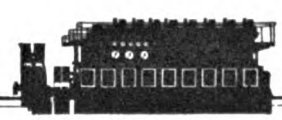
FOR the first time in American shipping history a set of powerful high-speed light-weight Diesel engines has been installed in a big cargo ship. Driving a single propellor with a 4000 s.hp. motor at 60 r.p.m. thru electric transmission, this system may mean a very big change in ship propulsion in America. It is a bold engineering step that required foresight as well as courage, and being done with the Government's money for Government ships, much criticism had to be met and opposition overcome by its sponsors. It will be a year hence, however, before sufficient service information can be secured from the COURAGEOUS, TRIUMPH and DEFIANCE to put forward substantial operation facts for shipowners. Those who have vision to see the Diesel-electric ship in its entirety feel quite confident as to its outcome, that far greater advantages will result than are expected, and that the step taken is a very wise one. In our opinion it will show surprisingly large advantages over every form of steam or steam-electric ship propulsion now being used.

There is one factor already very apparent. To the average Diesel builder of this country wholesale adoption of this form of power for large vessels is likely to aid greatly in reducing cost of manufacture of a given horsepower and simultaneously stimulating production. This in turn will benefit the shipowner. Here we have twelve engines ordered at one time—engines of a size also suitable for ferries, tugs and dredges as well as for land power-plants, all passing thru the shops together, possibly with half-a-dozen other engines of similar power. Quantity production, the ideal of all American engineering plants, is at once in sight.

What does this mean? Had the order been substituted by three big slow-speed crosshead engines for the same three ships, and with the same short time of delivery, the manufacturer would have been rushed with work in one section of his shop for six months. Special drawings, special patterns and



At Auburn, N. Y., exacting load tests were made of the four 8-cylinder McIntosh & Seymour Diesels of the Courageous



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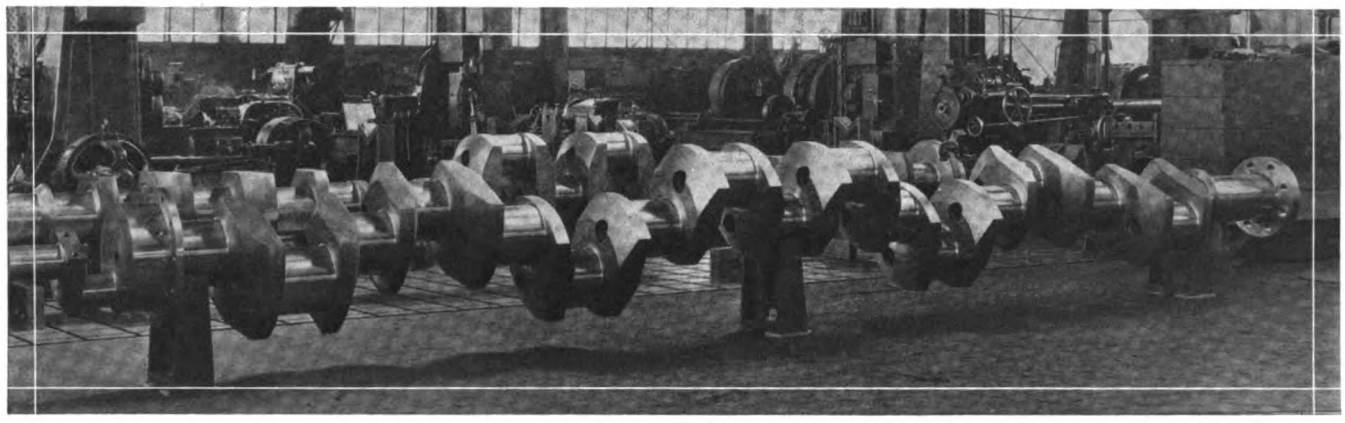
special castings would be required, and it would mean big machine tools that could only occasionally be put in operation because it is uneconomical to machine other small work on large tools. Then overnight, following delivery of the engines, is likely to come a slack period as duplicate orders for such huge engines are only secured now and then. Under such production conditions overhead is high.

Contrasting with this, orders for lower powered, lighter weight Diesels as installed in the COURAGEOUS and sister ships are far more easily and far more often obtained. They mean more constant production. Machine tools can be of smaller size and are kept in operation more continuously. Their cost is lower and can be replaced more often with the new designs of tools, as produced to speed production. After such engines are delivered, the void to be filled in the foundry and machine shops in the terms of horsepower is not likely to be so big as with massive slow-speed Diesels. In the ships the matter of overhaul is very much easier, is expedited, and spare parts cost much less.

All engines are alike except they are built in pairs; two right-hand and two left-hand engines being installed in each ship. One pair of engines is installed on each side of the ship engine-room, so the two operating sides come together. This produces two operating alleys with the exhaust sides of the two inboard engines together, making a convenient arrangement for operation and control.

The general design is compact and clean cut, as the illustration shows. Designed to make a unit of minimum over-all length, the dimension, including the flywheel, is but 31 ft. 8 in. The height too is small, an advantage on board ship. From the operating grating to the top of the fuel valve is but 11 ft. 7 in. Weights have been kept down; each engine including flywheel, generator-shaft and outboard-bearing weighing only 144 pounds per horse power at normal load.

The frame and base are each cast in one piece. They are of semi-steel and are well reinforced with ribs; a substantial rib structure supporting each main bearing seating. It can be seen that the joint between the base and frame comes at the center line of the shaft. The base is closed in at the bottom, and all lubricating oil is caught in this base where provision is made to drain to a sump tank.



One piece Erie crankshafts of the Courageous' Diesels are examples of modern forging.

For the COURAGEOUS twelve 8-cylinder Diesel engines each were ordered from McIntosh & Seymour Corporation, of Auburn, N. Y. Four of them will be connected to General Electric generators of 800 kw. each on the COURAGEOUS, and the other eight will be similarly installed on the TRIUMPH and DEFIANCE, but coupled to Westinghouse generators.

These McIntosh & Seymour Diesels are of the four-cycle, trunk-piston, air-injection type, each having eight cylinders with 20 in. bore by 24 in. stroke. They are designed to operate at a normal piston speed of 1000 ft. per minute consistent with today's tendency to run to higher piston speeds than in the earlier period of Diesel development. At this speed their rating is conservative. As the electric motor on the propeller shaft has a normal output of 4000 s.hp., but can deliver 4500 s.hp., there is plenty of reserve power. Furthermore, should ever one engine be temporarily out of commission, the other three can collectively deliver 4000 b.hp. to the generators for a good many hours.

Until a few years ago the box design of cylinder construction had been limited to crosshead engines, but gradually this rigid form of structure has been adopted by many builders of trunk-piston Diesels. It is to be found in the engines of the COURAGEOUS and sister ships. The upper part of the frame is a cast-iron box or tank into which the cylinder liners are pressed from the top, affording ample space without pockets for the salt water cooling. On the frame there are easily removable sheet-iron doors on both sides for inspection and overhaul purposes. These doors are placed opposite each crank, making it easy to get at the connecting-rod bearings.

As the engines are four-cycle, all valves are located in the cylinder heads, and each head has the usual air, exhaust and fuel valves. The guides for the exhaust-valve stems are water cooled. Each head is equipped with a starting valve and a safety valve.

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Simplicity is a feature of the valve gear. The valve levers are light, but strong steel castings. Each lever has a roller which bears directly on the cam. The cam shaft is driven by spur and bevel gears from the crankshaft through a vertical shaft. This vertical shaft also drives the governor, fuel pump and Manzel timed-force-feed lubricators.

The fuel pumps are located at the engineer's control station of each unit. Individual plungers deliver the fuel through pipes to each cylinder. One lever controls all the fuel pumps simultaneously, but many of the pumps may be cut-out individually at will. A governor, located near the engineer's stand, controls the fuel pumps direct through a lever and link. The lever, link and dash-pot, used to regulate the speed of control, can also be plainly seen. An overspeed control located directly back of the fuel pumps, is provided in addition to the controlling governor.

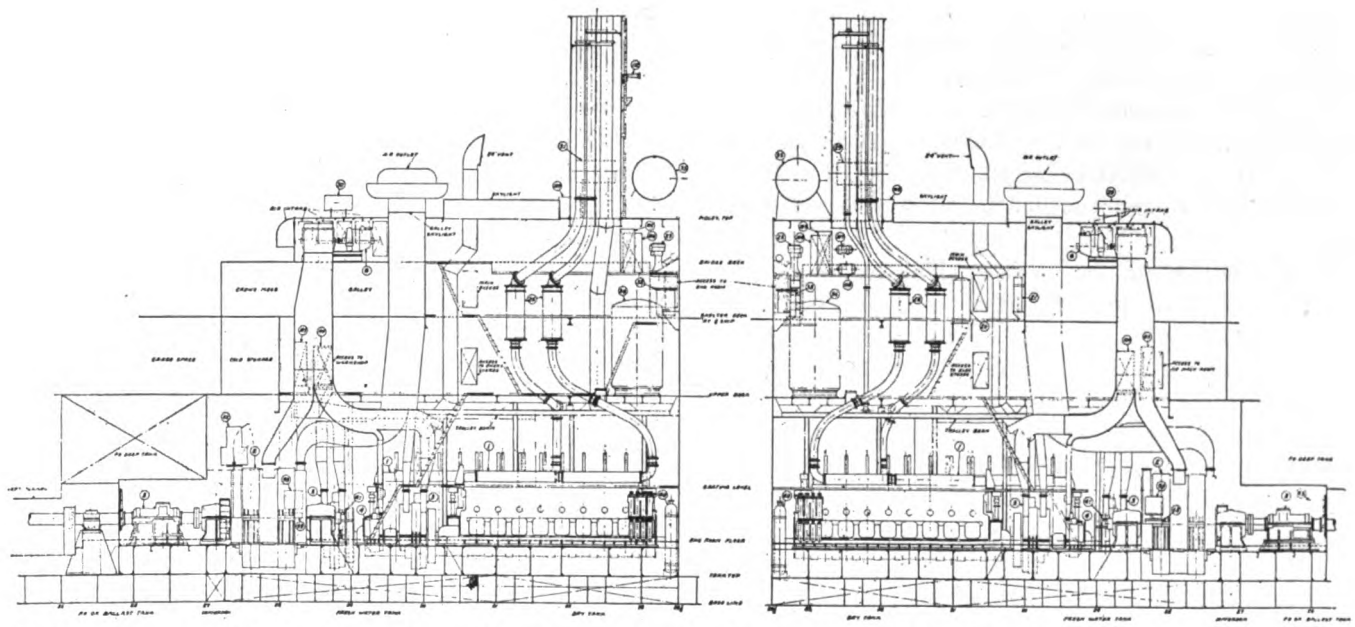
The engineer's control station just mentioned is located at the after-end of the engine. From this one position the engineer has full control of the engine. The fuel pump control handle, the starting air valve and the injection air valve are all located directly in front of the operator. The gauge board and the mechanical lubricator are also conveniently located in front of the operator. Mounted on the gauge board are instruments showing air, water, lubricating oil and piston-cooling oil pressures, and a mechanically driven tachometer.

A three-stage air compressor is mounted on the forward end of the engine, driven by a crank on the forward end of the crankshaft. The straight tube cooler is located in such a way as to make the air connecting piping short and inconspicuous, the tube bundles of the various stages are interchangeable. This permits carrying one spare bundle, which can be quickly placed in any stage.

Oil cooling has been adopted for the pistons. Thermometers and sight flow indicators are placed in the outlet from each piston. Swinging joints are located inside the frame, but so designed as to be readily accessible through the crankcase doors on the exhaust side of the engine, conduct the oil to and from the pistons. Incidentally, it may be said that the various pipe lines have been carefully laid out to make a neat and workmanlike installation.

The crankshaft in each case is a solid Erie forging 29 ft. 2¼ in. long, with the compressor end forged integral. Pins and journal are 13 in. in diameter, and its weight 20,450 lbs.

One feature of this engine construction is its remarkable stiffness. The base and frame—to which we already have referred—are both deep one-piece castings, which when bolted together makes deflection at any point negligible. An illustration of this stiffness can be seen in the fact that the complete unit can be lifted after assembling. This feature is also a convenience, for it is necessary to remove only a minimum number of parts for shipment on a flat car. One of these engines is shown (page 11) on the car ready for shipment, while another illustration demonstrates the stiffness of these enginges, one of the main engines being shown held supported only at its two ends by a large crane, preparatory to lowering it into the engine-room of the motorship COURAGEOUS, at the Federal shipyard where this ship was rebuilt and the Diesels installed under the supervision of the engine builders.



Engine exhaust piping and air ducts have been arranged to fit the existing machinery space, as shown by the port and starboard elevations respectively.

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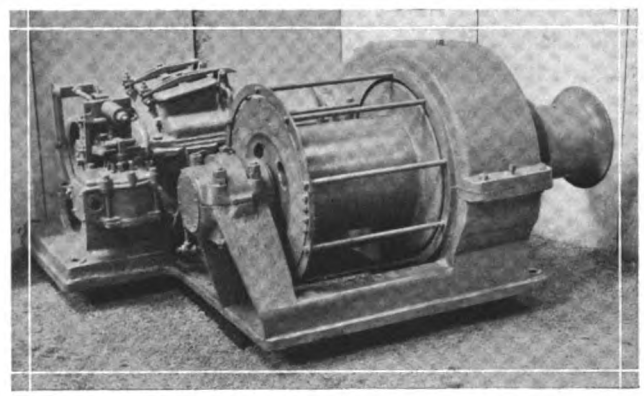
STEAM For Deck Power Virtually Disappeared With Era of The Modern Motorship.

Electrically Driven Deck Machinery

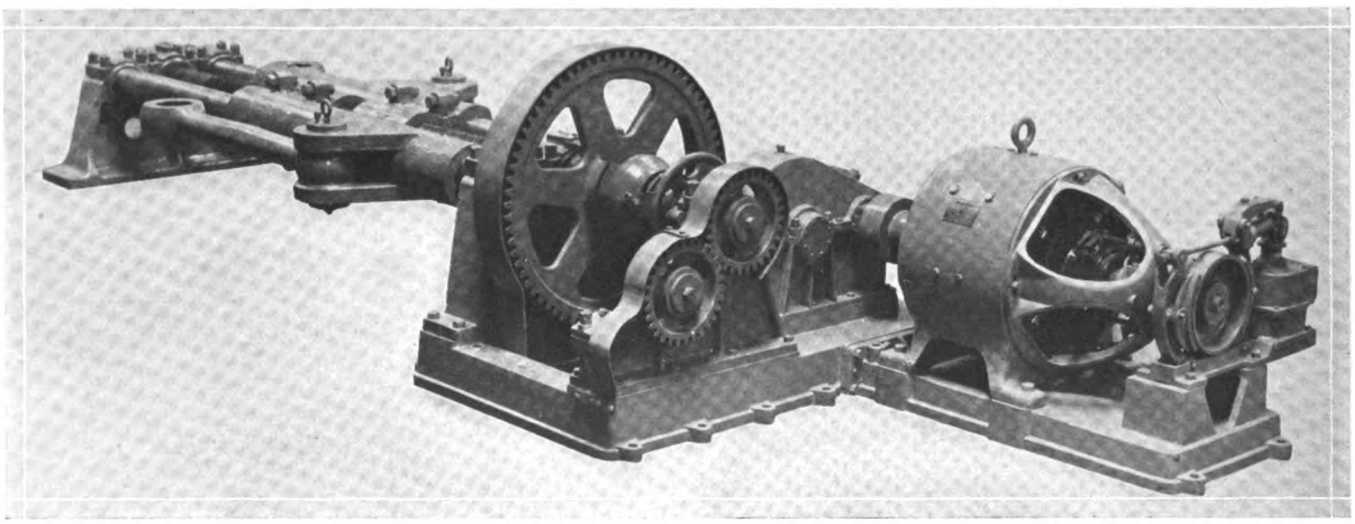
Courageous, Defiance and Triumph All Have Hyde Winches, Windlass and Steering Gear.

CONVERSION of the COURAGEOUS from steam to Diesel drive required extensive changes to the auxiliary machinery, as well as to the main power plants. All the old uneconomical steam winches were scrapped and replaced by twelve modern electric winches, but the windlasses, warping winches, and steering gears were reconstructed and changed to the electric system. In a way this turns back the clock nearly fifteen years to the Danish motorship SELANDIA, in which vessel steam was entirely eliminated for the first time and all the deck machinery electrically driven. Such a radical change was strongly criticised in some marine quarters at the time; but the low cost of producing electric current by auxiliary Diesel power made such unbelievable economies when handling cargo in port, and cargo handling speed increased so rapidly, that in a few years the system became standardized for motorships. Later many American steamships adopted electrical power for this purpose, regardless of the fact that it costs at least five times as much to generate electrical current for auxiliary power when in port as it does with Diesels. Consequently it is not surprising that a number of steamers recently built abroad have a special Diesel auxiliary engine-room for taking care of the port load.



Each winch is equipped with a 25 horsepower waterproof motor and has one drum and one gypsy on the end of the drum shaft.

In the case of these three Shipping Board conversions, all the 36 new electric winches were entrusted to the Hyde Windlass Company, Bath, Me., to construct—an old established concern which has



In changing over the steering gear a 45 horsepower electric motor with reduction gear unit was assembled complete on one bedplate, after all of the original steam gear was removed.

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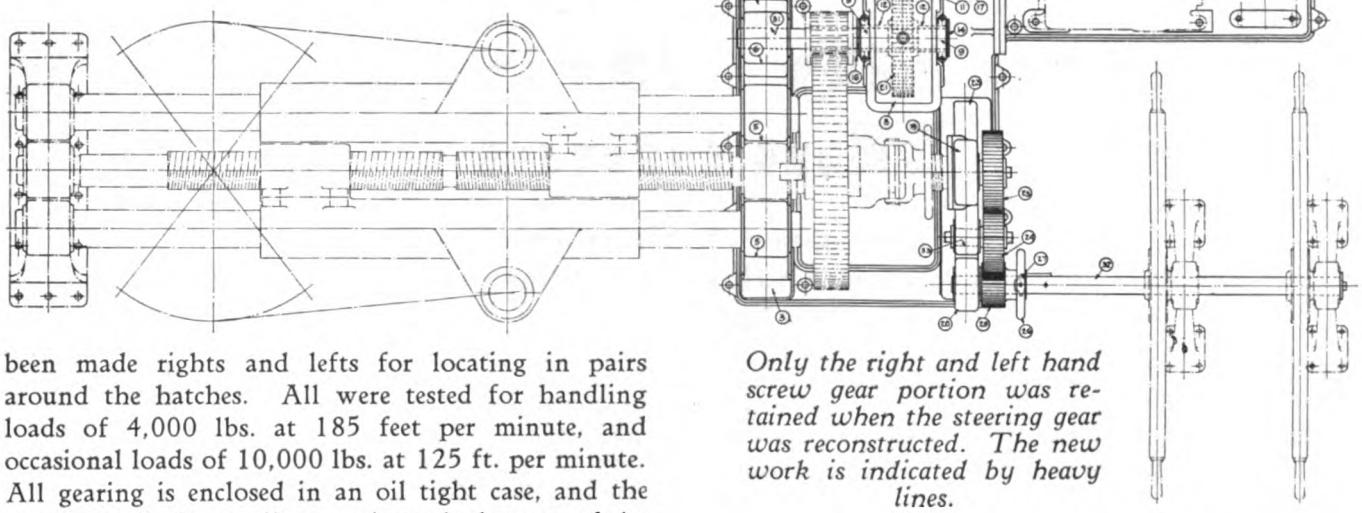
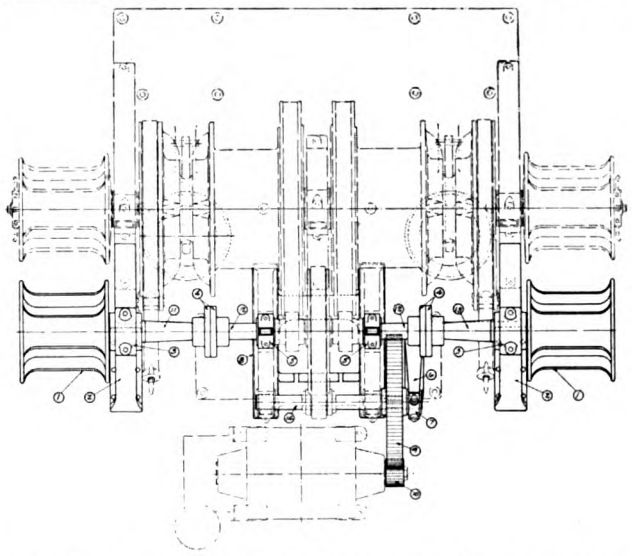
had much experience in this direction. Each winch is equpiped with a 25 b.hp. waterproof motor fitted with shoetype brakes, self contained on the same bedplate. The winches have one drum and one gypsy on the end of the drum shaft. The Winches have



Only the right and left hand screw gear portion was retained when the steering gear was reconstructed. The new work is indicated by heavy lines.

been made rights and lefts for locating in pairs around the hatches. All were tested for handling loads of 4,000 lbs. at 185 feet per minute, and occasional loads of 10,000 lbs. at 125 ft. per minute. All gearing is enclosed in an oil tight case, and the gear teeth dip in an oil reservoir at the bottom of the



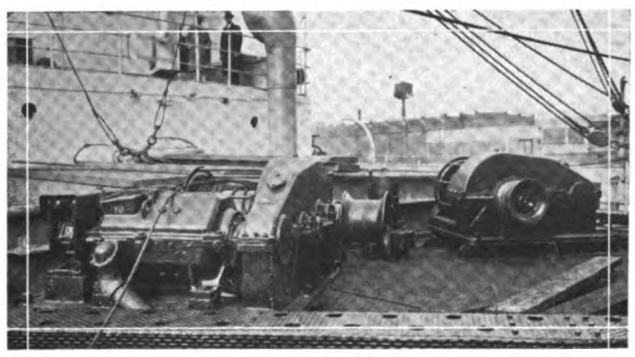
Retained parts of windlass and electric motor shown by dotted line.

casing, thus automatically supplying lubricant to the bearings of the winch. The latter are lined with high-grade anti-friction metal. All gears are of cast steel, machine cut, with pinions of forged steel. The teeth of the gearing, of course, are machine cut.

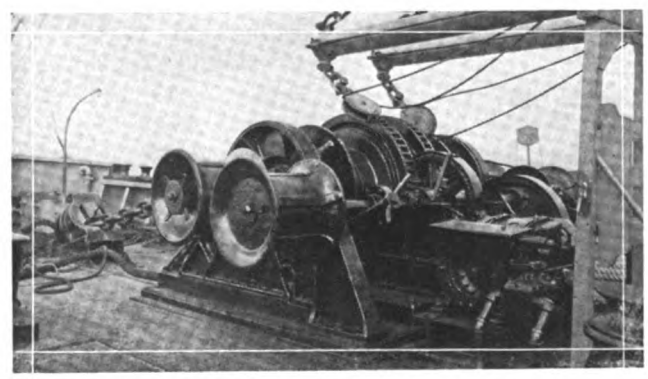
As regards the windlass, that of the COURAGEOUS is illustrated.

The steam-engine parts were eliminated entirely, and only the main windlass shaft with parts thereon, together with windlass bedplate shown in light lines, were used. A 75 HP marine motor was installed in connection with the reduction gearing, shafting and bearings on the windlass bedplate. These parts are indicated in heavy line on the same drawing. Large warping heads for quick handling of lines were fitted on ends of windlass shaft.

In changing over the steering gear—also illustrated—only the right and left hand screw gear portion was retained. A 45 HP marine motor, with reduction unit assembled complete on one bedplate, was substituted in place of the steam engine. All these parts are indicated in heavy lines. The photographic reproduction shows the complete screw gear with motor reduction gear as installed on the TRIUMPH and DEFIANCE.



Two of the twelve electric winches installed on the Courageous



After reconstruction the anchor windlass was comparable to new.

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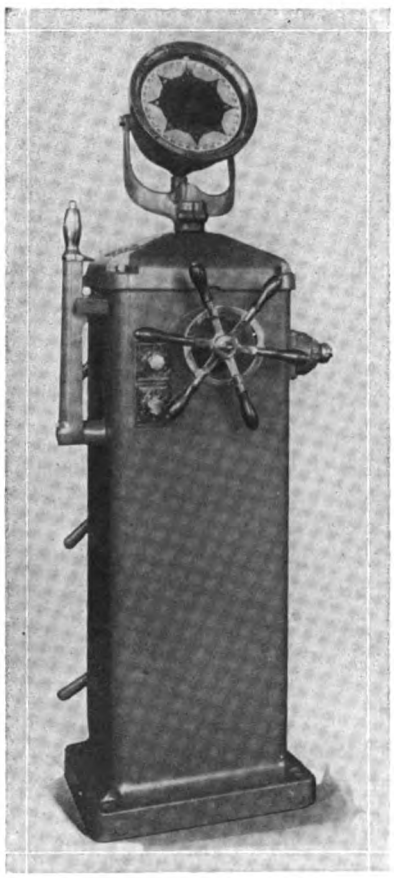
The Mechanical Navigation Element

DIESEL-Electric Conversions Have Latest Gyro Equipment To Eliminate Human Error In Steering

THOSE two highly important parts of every ship, the compass and steering equipment, are thoroughly modern on the COURAGEOUS and sister conversions. The Sperry Master Gyro-Compass and its auxiliaries are mounted in a special compartment. A Steering Repeater Compass is mounted at the steering position and a Bearing Repeater Compass is mounted in a gimbaled stand above the wheelhouse.

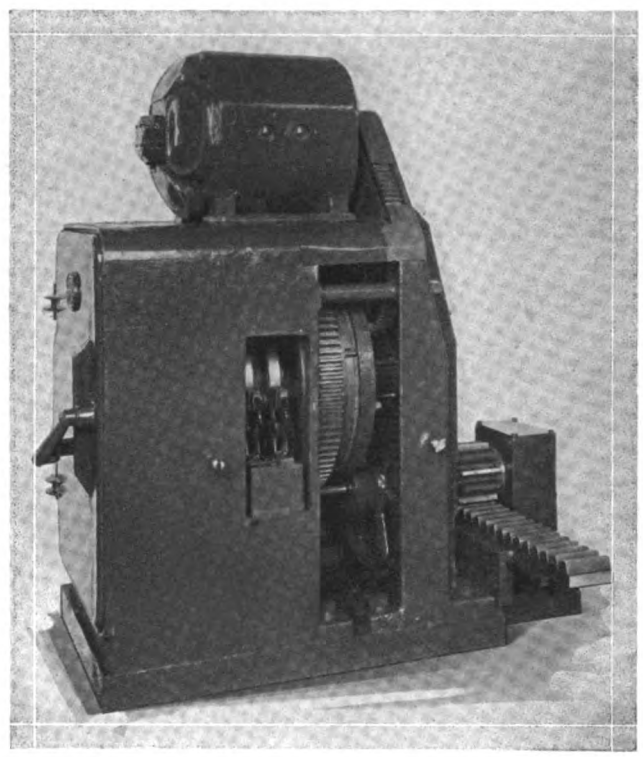


A steady course is maintained by this automatic steering device.

The steering equipment includes a Sperry two unit Gyro-Pilot which, in addition to providing automatic steering, gives a second method of steering which is completely independent of the hydraulic telemotor system. This type of Gyro-Pilot is built around the same principles as the single unit type which is attached directly to the steering wheel. Instead, however, of operating the steering wheel, the two unit type operates the control mechanism of the steering machinery aft. Connection to the control gear aft is made through a sturdy magnetic clutch which is controlled from the bridge.

A selective lever on the steering or wheelhouse unit determines the relation of the Gyro-Pilot to the steering gear of the ship. When this lever is placed in the "wheel" position, the ship is steered from the steering wheel on the Gyro-Pilot stand. The relation of rudder motion to this wheel is exactly the same as that of the hydraulic telemotor wheel. When the lever is in the "gyro" position the ship is steered automatically. The wheel in this case becomes a course changer. If, for example, it is desired to change course to the starboard four degrees, the wheel is put over to the starboard two turns. The Gyro-Pilot then applies the necessary rudder and steadies the ship exactly on the new course without any further attention on the part of the man on the bridge. When for any reason it is desired to steer by means of the hydraulic telemotor system, the lever is put in the "off" position. This opens the circuit to the magnetic clutch aft through which the after Gyro-Pilot unit is connected to the control mechanism of the steering gear. The latter immediately centralizes itself, and then is ready to take up control from the hydraulic telemotor wheel up forward.

This system of automatic steering has two very outstanding advantages. By eliminating telemotor lag and lost motion, a truly ideal steering combination is presented in which yaw indication and corrective rudder movement are practically simultaneous. The rudder indicator sometimes shows rudder movement before it is apparent at the compass. The other advantage of this equipment is a second, independent steering control system which it provides.



On the Courageous a steering gear suitable for small vessels is controlled by the Metal-Mike, and in turn controls the main steering gear.

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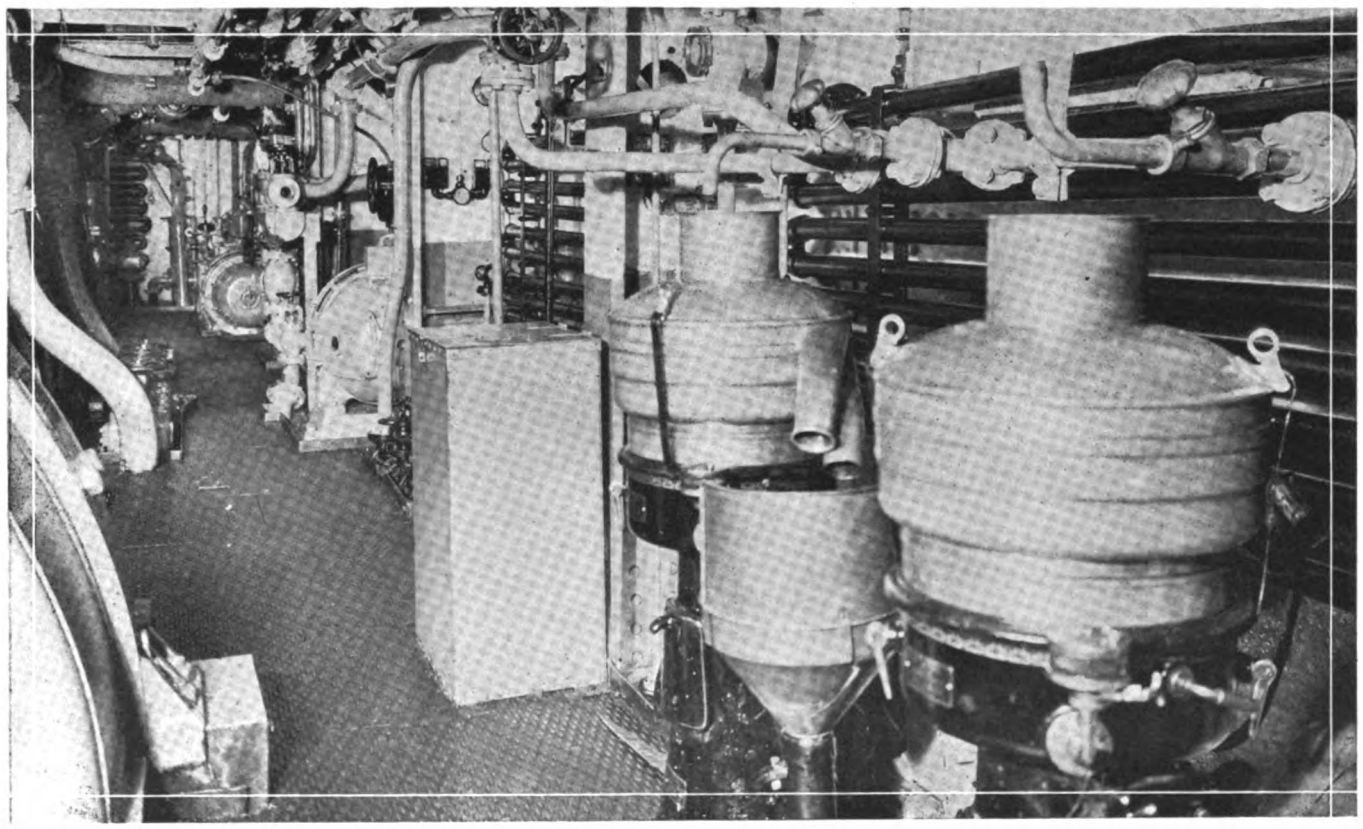
Cleaning Fuel and Lubricating Oils

COURAGEOUS, TRIUMPH AND DEFIANCE Are Equipped With De Laval and Sharples Centrifugal Appliances For Removing Foreign Matter

IT is generally agreed that the use of centrigugal purifiers constitutes an ideal means of removing oil impurities. These machines have been developed to a point of perfection whereby they not only efficiently perform the work for which they are built, but they also fit into the general scheme of engine room installations in a manner not equaled by any common method of oil filteration.

The centrifugal system as arranged on the COURAGEOUS, TRIUMPH and DEFIANCE are so carefully planned that not a single drop of contaminated fuel or lubricating oil need reach the engines. On the COURAGEOUS two De Laval vaportight fuel-oil purifiers and two open-type lubricating-oil purifiers of the same make are used. These have a maximum capacity of 600 g.p.h. and 350 g.p.h. respectively. They provide a surplus capacity so that only one machine in each system is needed and the other may be held as a stand-by. On the TRIUMPH and DEFIANCE the systems are the same except that the centrifuges have been supplied by the Sharples Specialty Company.

The maximum rated capacity of centrifugal purifiers is based upon their actual performance under ideal test conditions. Such conditions seldom exist aboard ship and it is safe to assume that something less than the maximum rated capacity will be the average. Basing the estimate upon this assumption and calculating the average in service rate of each fuel oil purifier to be 500 g.p.h. it would then be necessary to operate one machine only half of the time. During the other half the machine may be



The lubricating oil purifiers are installed in the lower engine room on the starboard side.

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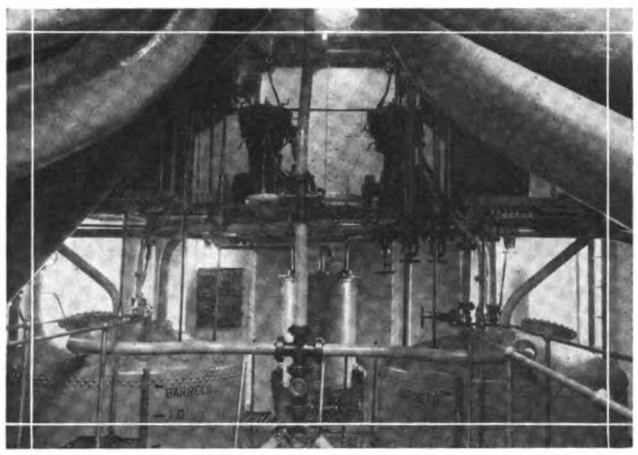

Fuel oil purifiers are located on a balcony above the daily supply tanks.

cleaned, but failing to do so the stand-by unit may be put in service within a few minutes.

The general arrangement on these vessels is such that fuel is first pumped from the main tanks into an 80 bbl. (3,360 gal.) raw oil tank, located above the engine room on the deck house. This tank is heavily lagged and fuel in it may be heated to the desired temperature and then passed by gravity into one of the purifiers located on a balcony in the upper forward part of the engine room. After leaving the purifiers it flows down to one of two daily supply tanks, each with a capacity of 75 barrels and located in the forward part of the engine room at a level somewhat higher than the fuel pumps on the main engines.

The lubricating oil purification system is equally simple even though it provides three separate methods of operation. Purifiers of large capacity are provided because the same oil is used for piston cooling and bearing lubrication. During normal operation this oil is merely pumped from the sumps through strainers and coolers and then to the bearings and pistons. If for any reason it is deemed necessary to purify the oil in service, and while the engines are in operation, a portion of it may be by-passed through one or both of the purifiers. An alternative method would be to remove a portion of the oil in use and put it in one of the four 1,200 gallon settling tanks; at the same time replacing the oil removed with an equal amount of clean oil. The oil in the settling tanks then may be purified as a batch and put back into the system and an equal amount removed.

One of the Sharples fuel oil centrifuges used on the Defiance and Triumph.

At the end of the voyage when the engines are being repaired, or while the crank pits are being cleaned, all of the oil may be pumped up into the settling tanks and held. When about ready to sail the oil may be returned through the purifiers, in a perfectly clean condition, at a rate of 600-700 g. p. hr.

One of the De Laval fuel oil purifiers installed on the Courageous.

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Motorship

FEDERAL

Shipbuilding Conversion . Reconditioning Repairs.....

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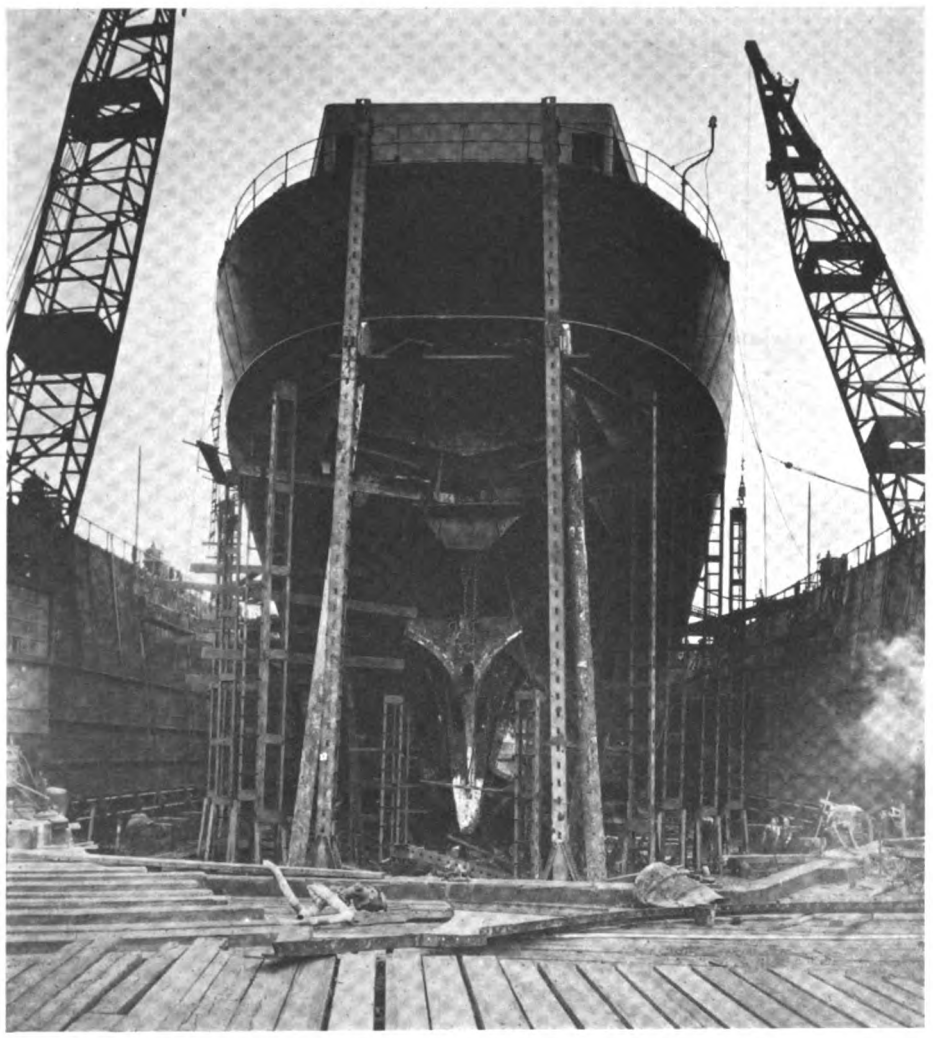
COURAGEOUS

AN important addition to the American merchant marine in Far Eastern service, the COURAGEOUS is a distinguished tribute to the unparalleled Federal record of experience in motorship conversion and construction.



THE completed COURAGEOUS, moored in the Federal dock, is shown at the right.

At the left is a view from astern during the progress of conversion.

Federal

Kea

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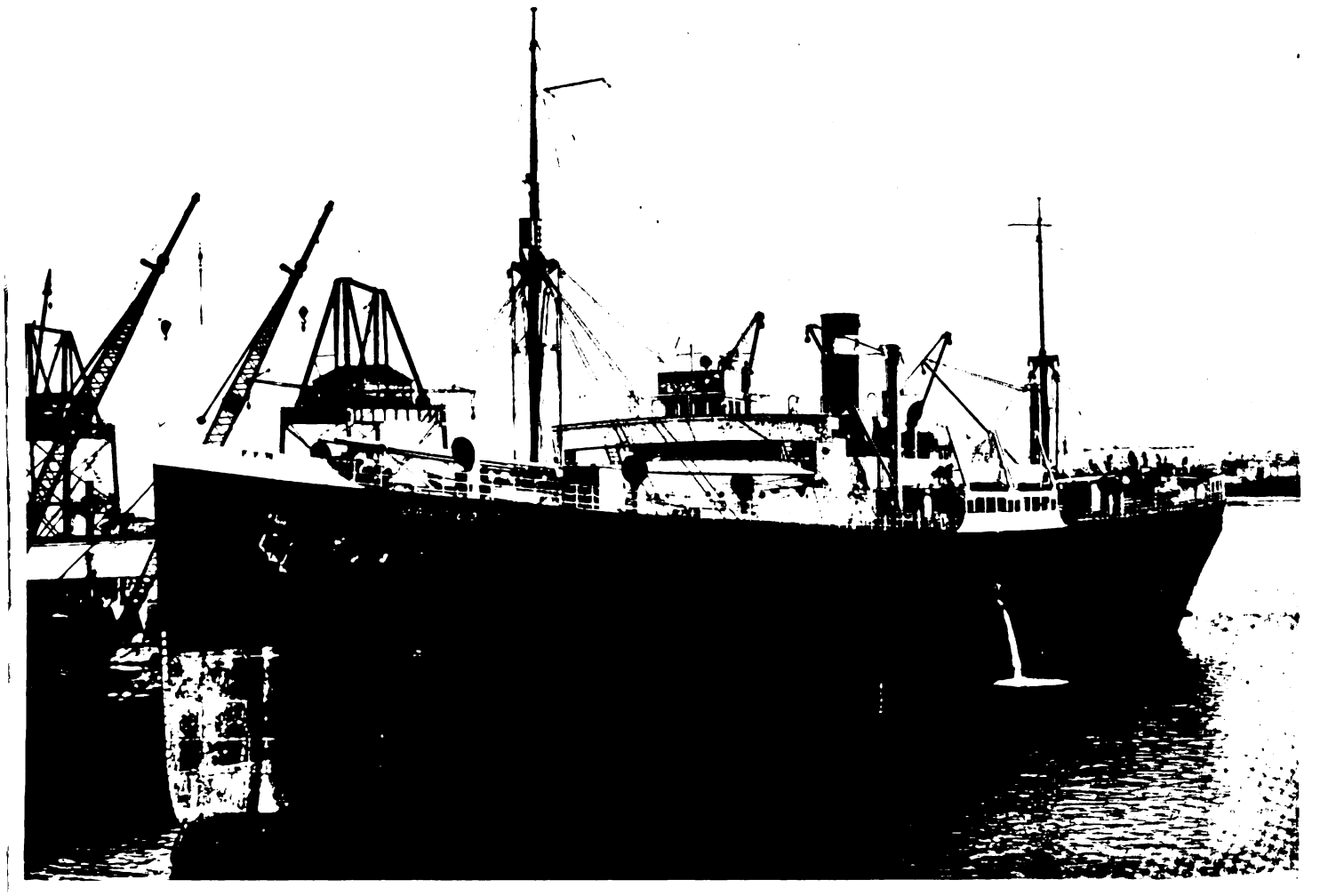
a Federal conversion



hipbuilding & Dry Dock Co.

General Offices and Works
LINCOLN HIGHWAY

n y, New Jersey

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Motorship

Federal
built or converted
Motorships

The COURAGEOUS is a notable addition to the fleet of FEDERAL-BUILT MOTORSHIPS.

(At the left) "Steel Electrician," "Steel Vendor," "Steelmotor"

(At the right) "E. T. Bedford," Dredge "Willets Point," and "Steel Chemist"

(Below) The "Gulfpride"

Federal Shipbuilding & Dry Dock Co.

Lincoln Highway
Kearny, N.J.

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